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Systematics and Phylogeny of the Anthophorine Bees (Hymenoptera: Anthophoridae; Anthophorini)

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CONTENTS

ABSTRACT

The genera and subgenera of the cosmopolitan tribe Anthophorini are reviewed. Genera and subgenera are separated by keys, are described, included species are listed and pertinent morphological features illustrated. Two monophyletic genera are recognized. (1) *Anthophora* consists of 14 subgenera of which the following seven are new: *Pyganthophora* (type species, *Apis retusa* L.), *Lophanthophora* (type species, *Anthophora porterae* Ckll.), *Petalosternon* (type species, *Anthophora rivolleti* Pérez), *Dasymegilla* (type species, *Apis quadrimaculata* Panzer), *Rhinomegilla* (type species, *Anthophora megarrhina* Ckll.), *Caranthophora* (type species, *Anthophora dufourii* Lep.), *Mystacanthophora* (type species, *Anthophora montana* Cress.) and (2) *Amegilla* consists of 11 subgenera of which seven are new: *Megamegilla* (type species, *Apis acraensis* Fab.), *Ackmonopsis* (type species, *Anthophora mimadvena* Ckll.), *Micramegilla* (type species, *Anthophora niveata* Friese), *Glossamegilla* (type species, *Anthophora mesopyrrha* Ckll.), *Notomegilla* (type species, *Anthophora aeruginosa* F. Smith), *Zebramegilla* (type species, *Anthophora albigena* Lepeletier) and *Dizonamegilla* (type species, *Megilla sesquicincta* Erichson and Klug). *Solamegilla* Marikowskaya is placed as a synonym of *Paramegilla* Friese and *Micranthophora* Cockerell as a synonym of *Heliophila* Klug. New species described are *Anthophora (Anthophoroides) signata, A. (Anthophoroides) phaceliae, A. (Mystacanthophora) bahamensis, A. (Mystacanthophora) boharti, A. (Caranthophora) spinacoxa, A. (Heliophila) joetta, A. (Heliophila) micheneri, A. (Pyganthophora) adamsorum; Amegilla (Micramegilla) canifronoides, A. (Micramegilla) capeverdensis, A. (Micramegilla) modestoides, A. (Glossamegilla) lieftincki, A. (Aframegilla) elsei, A. (Aframegilla) robinae, A. (Megamegilla) paradoxa, A. nonconforma, A. (Asaropoda) epaphrodita and A. (Asaropoda) houstoni.* Probable cladistic relationships are given at the tribal, generic and subgeneric levels. A biogeographical discussion of subgeneric groups is included. See Appendix 2 for lectotypic and neotypic designations, and Appendix 3 for newly recognized homonymy, new synonymy, a list of all names that have been applied to species and subspecies of Anthophorini and Habropodini, and an index to specific names. In addition the genus *Emphoropsis* is synonymized under the now holarctic and oriental genus *Habropoda.*

INTRODUCTION

This study provides a classification and proposes a phylogeny for the genera and subgenera of anthophorine bees. The tribe Anthophorini, worldwide in distribution, and considered here to include only two genera, *Anthophora* and *Amegilla,* is distinguished from other Anthophorinae by three submarginal cells, the first recurrent vein meeting the posterior margin of submarginal cell 2 near its midpoint, the forewing with simple alar papillae, the second abcissa of vein M + Cu of the hind wing subequal in length to the cu-v crossvein, and the elongate, narrow gonostylus (if present) never flattened and paddle shaped. The Habropodini consisting of *Deltoptila, Elaphropoda, Habropoda (= Emphoropsis* **n. syn.***), Habrophorula* and *Pachymelus,* and formerly included in the Anthophorini, are as distinct from the Anthophorini as the Emphorini are from the Eucerini.

Anthophorine bees are mainly xerophilic and abundant in Mediterranean climates. Among the North American species over 90% occur in the dry southwest. In the Old World, where most anthophorine bees occur, the most speciose area is the Mediterranean Region. Of the 14 subgenera of *Anthophora* eight are found in the New World; only one is restricted to that area. They are scarce in tropical forests but are often found in tropical montane environs. *Amegilla* is strictly Old World and flies in the summer, while *Anthophora* is worldwide in distribution and commonly flies in the spring.

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HISTORICAL REVIEW

The following review deals only with major steps in establishment of the supraspecific taxa and classification. The systematic history of each genus and subgenus is associated with its description and is only mentioned briefly here. Because of the similarity of Habropodini and Anthophorini, most authors have either confused them or regarded them as a single tribe. Therefore the Habropodini are included in the subsequent paragraphs.

Linneaus described the first anthophorine bee as *Apis retusa* (1758). In the same work he also described *Apis acervorum,* which he first mentioned in 1746 and was thought by subsequent workers to be an anthophorine bee after being misidentified by Fabricius (1775). Not until recently, however, was it discovered that *A. acervorum* probably was a bumble bee (Day, 1979; Løken, 1973; see *Comments* under *Anthophora* s. str.). The second genuine anthophorine species described was *Apis plumipes* Pallas (1772), which is conspecific with the *A. acervorum* of Fabricius and with *A. pilipes* Fabricius (1775). Latreille described the first anthophorine genus, *Podalirius,* in 1802b but this name was suppressed (Hemming, 1944) by the International Commission on Zoological Nomenclature (ICZN). Latreille proposed *Anthophora* (1803) as a replacement for *Podalirius* on the ground that the latter was preoccupied in plants. *Anthophora* became the type genus for the tribe, subfamily and family. Fabricius named a genus *Megilla* [1805] which originally included species that we now recognize to be in the Hylaeinae (Colletidae), Halictinae and Nomiinae (Halictidae), Melittinae (Melittidae), Exomalopsini, Habropodini and Anthophorini (Anthophoridae), and the Bombini (Apidae). The name *Megilla* is now regarded as a junior synonym of *Anthophora* (Michener, 1984).

Latreille (1802a) proposed the group Podalirii based on the genus *Podalirius.* Dahlbom in 1835 placed *Anthophora* in his tribe Anthophorini. Once *Podalirius* was suppressed by the ICZN (Hemming, 1944) to conserve the name *Anthophora,* it was no longer available as the type genus for a higher categorical name and Dahlbom's tribal name became valid (see Michener, 1986).

A historical review of developments at the generic and specific levels will be found in Brooks (1986).

METHODS

I have sought to examine every species and have been able to see over 90% of the described species in the Anthophorini and Habropodini. Types were studied from al-

most all major collections as well as determined and undetermined material in these collections so that as many species as possible could be placed in their appropriate groups. I have attempted to make known the unusual as well as common attributes of anthophorine species so as to facilitate future revisionary studies of the various groups at the specific level.

All structures which could be studied flattened, such as sterna, were placed on slides in glycerine for illustrative purposes. Larger structures such as the genital capsule and mouthparts were dissected and studied in either alcohol or glycerine. Terminalia and mouthparts were cleared overnight at room temperature in about 10% KOH and then transferred to one or two changes of water for several hours (sometimes acidulated water), finally to glycerine for study and long-term preservation.

Preparation of specimens for scanning electron microscopy entailed initial relaxing in a humidifier for one to two days. Parts were taken from the specimens and ultrasonicated in three warm baths (five minutes each): the first, water with a detergent; then 70% alcohol; and finally, xylene. The structures, if relatively hairless, were allowed to air dry; if hairy they were dried with air blown through a piece of surgical tubing attached to a micropipette. The specimens were then mounted with glue (casein) on stubs coated with Tubekote® so as to give a uniform black background. Specimens were coated with 200 Å of gold-palladium and scanned with 15 Kv (200 spot size), using a Phillips 501 scanning electron microscope.

Morphological terminology follows for the most part Michener (1944) and for mouthparts, in certain cases, Winston (1979). New terms for structures are explained in the section on *Characters Employed.* The proboscis is regarded as projecting downward from the head. Thus the anterior surface of the mentum is the surface that would be called dorsal if the proboscis were considered to project forward. To save space the metasomal segments are abbreviated S for sternum and T for tergum. Therefore sternum 6 is termed S6 and tergum 6 is T6, etc. Almost all Anthophorini have bidentate mandibles and apically simple labra, thus only exceptions to these are listed. All capitalized colors are from Ridgway (1912) except dark browns and other nonspecific generalized terms (e.g., dark brown, ferruginous, amber.) All characters of surface sculpture are described using the system of Harris (1979) and were examined under fiber-optic illumination diffused by frosted drafting film to eliminate reflections.

Illustrations of terminalia and mouthparts were drawn from cleared material using a drawing tube. On shaded drawings the light was positioned so as to strike the subject from the upper left. For figures of the upper (anterior) views of maxillae, the whole maxilla was slightly flattened under a coverslip. The orientation of the lacinia and penis are not standardized and thus their shapes are not meaningful.

Comments on distributions were prepared from data taken from specimens and almost always not from the literature, because there are many misidentifications in the latter.

The generic and subgeneric descriptions take into account all characters described in the *Characters Employed* section and follow the same lettering system to facilitate comparisons. That is, the characters of the genera are directly comparable, and the characters of the subgenera within a genus are comparable, but not the characters of subgenera of different genera. Major as well as minor trends of variation are noted in the descriptions. When one or a small group of species differed from the majority in a character, the differences and species involved are indicated in parentheses. Structures which are described without indication of sex pertain to both sexes.

Genital capsules were drawn with left and right sides illustrating the dorsal and ventral surfaces respectively. Dashed lines represent hidden internal structures, while dotted lines indicate ridges or denote areas of dark sclerotization. Dot matrices represent the penis and other membranes of the genital capsule.

Type depositories of new species described in Appendix 1 are indicated within brackets, according to the following list: [Ansfelden], Austria, Collection of M. Schwarz; [Berkeley], University of California; [Budapest],

Hungarian Natural History Museum; [Berlin], Museum fur Naturkunde, Humboldt-Universität; [Buenos Aires], Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"; [Cambridge], Museum of Comparative Zoology; [Canberra], Australia, C.S.I.R.O.; [Copenhagen], Zoologisk Museum; [Davis], University of California; [Eberswalde], Deutsches Entomologisches Institut; [Frankfurt], Forschungsinstitut Senckenberg; [Geneva], Muséum d'Histoire Naturelle; [Genoa], Museo Civico di Storia Naturale; [Lawrence], Snow Entomological Museum, University of Kansas; [Leiden], Rijksmuseum van Natuurlijke Historie; [Lenigrad], Zoological Institute, Academy of Sciences of the U.S.S.R.; [Logan], Bee Biology and Systematics Laboratory, Utah State University; [London], British Museum (Natural History); [Los Angeles], Natural History Museum of Los Angeles County; [Moscow], Zoological Museum, Moscow State University; [Ottawa], Biosystematics Research Institute; [Paris], Muséum National d'Histoire Naturelle; [Perth], Western Australia Museum; [Pretoria], Transvaal Museum; [Pullman], Washington State University; [Riverside], University of California; [San Francisco], California Academy of Sciences; [Turin], Museo ed Istituto di Zoologia Sistematica; [Urbana], Illinois Natural History Survey; [Vienna], Naturhistorisches Museum; [Washington], National Museum of Natural History.

Cladistic analysis was aided by the computer program PAUP (Swofford, 1984). The methodology, based on parsimony, is the same as that followed by Snelling and Brooks (1985). The outgroups for the Anthophorini were the Habropodini and the rest of the Anthophorinae. In this study the expression "anthophorine bees" refers to bees of the tribe Anthophorini. Tables 1 and 3 include notes on the distribution of characters of the variables and the bases for my judgments of polarity (evolutionary direction). Discussion is frequently abbreviated but is sufficient to suggest reasons for my decisions. Tables 2 and 4 contain the data used to construct the cladograms. When a character is not constant within a taxon it is shown as P in Tables 2 and 4. In such cases the plesiomorphous state was used in the analysis.

Appendix 1 contains descriptions of new species referred to in the body of the text. Appendix 2 is lectotypic and neotypic designations and Appendix 3 is a list of species-group names indicating present generic assignments, synonymies, new combinations in the Habropodini (a few in the Eucerini), clarification of certain nomenclatural problems, and an index (the last entry under each name within parentheses and bold face is the page number or page numbers where that name is referred to in the text). The text contains new combinations of Anthophorini.

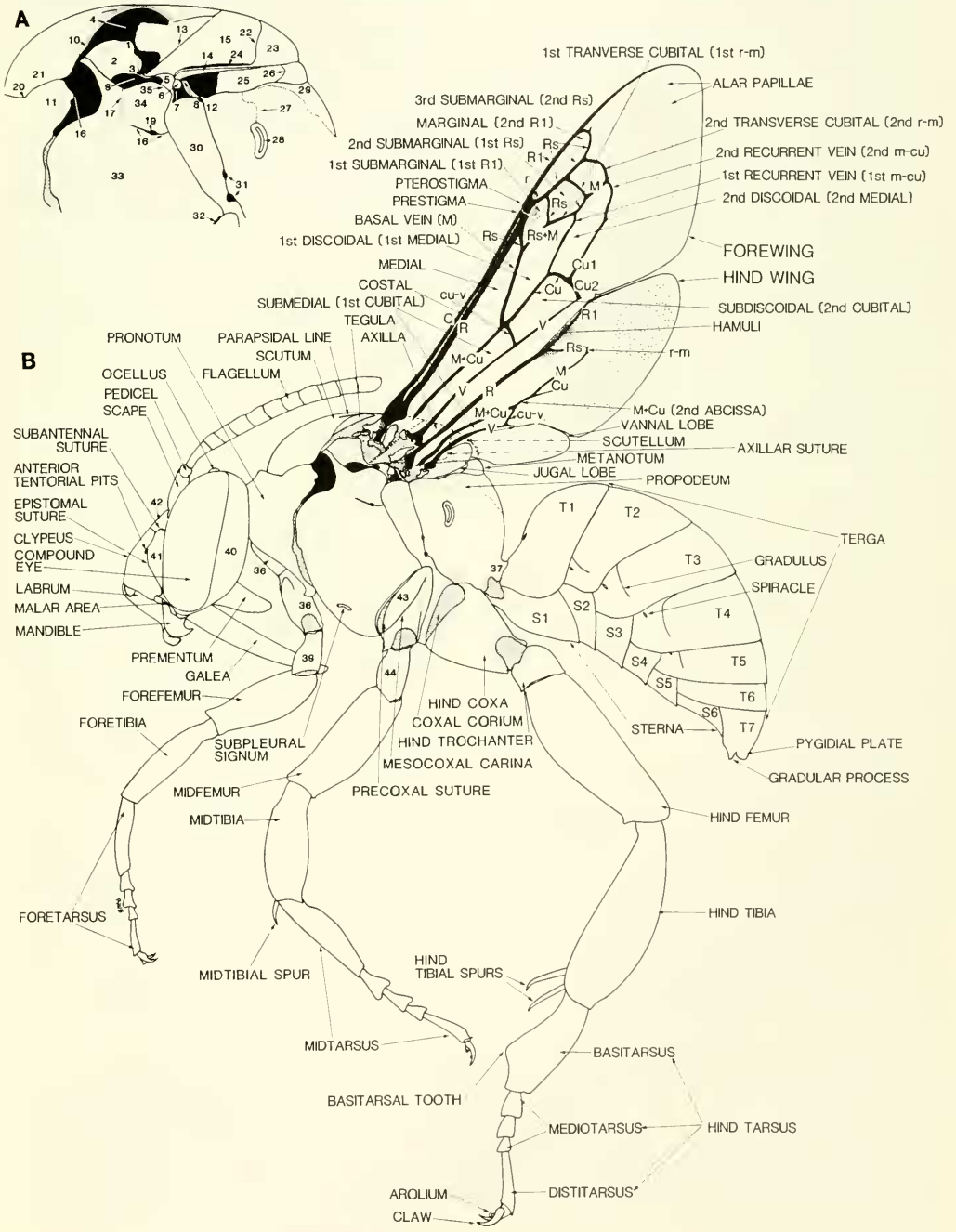
CHARACTERS EMPLOYED

From the great number of possible characters, I selected those that showed discrete differences among the taxa and were more or less invariable in at least certain taxa. Of course this is a circular process since the taxa are recognized on the basis of the more or less invariable characters. Recognition of taxa on largely or wholly phenetic bases, however, is an essential prelude to further analysis.

I have attempted to find easily observed external characters but unfortunately most of the distinctive group characters were

FIG. 1. A, Side view of *Anthophora (Paramegilla) centriformis* male with hair omitted; upper two-thirds of thorax with wing removed. B, Complete side view. 1. Tegular articulation. 2. Subalar area. 3. Anterior metanotal wing process. 4. Preaxilla. 5. Mesepimeron. 6. Peritreme. 7. Metaspiracle. 8. Pleural wing process. 9. Subalar pit. 10. Supra-alar carina. 11. Pronotal lobe. 12. Metapleural suture. 13. Transscutal suture. 14. Scutellar crest. 15. Axilla. 16. Mesospiracle. 17. Pre-episternal suture. 18. Scrobal suture. 19. Episternal scrobe. 20. Anterolateral angle of scutum. 21. Anterolateral process. 22. Axillar suture. 23. Scutellum. 24. Axillar fossa. 25. Dorsolateral metanotal area. 26. Transmetanotal suture. 27. Spiracular suture. 28. Propodeal spiracle. 29. Propodeal triangle. 30. Metepisternum. 31. Metapleural pits. 32. Mesokatepisternum. 33. Mesepisternum. 34. Hypoepimeral area. 35. Mesopleural suture. 36. Propleuron. 37. Marginal area of propodeum. 38. Forecoxa. 39. Foretrochanter. 40. Genal area. 41. Paraocular area. 42. Supraclypeal area. 43. Midcoxa. 44. Midtrochanter.

found in the male terminalia and mouthparts, therefore requiring dissections. Anthophorine females have proven difficult to separate and to place in groups; for the most part, the subgeneric groups of Anthophorini are based on characters of males. The sting apparatus was remarkably consistent among the taxa and not found useful for placing females in groups. The mouthparts and genitalia were dissected for almost all described species as well as many undescribed ones. The measurements reflect the variation



found in all species of a taxon, but often only a single specimen of each species was dissected. Nonetheless, the study of genitalia and mouthparts of individuals of a few common species and of as many species of each subgenus as were available shows that these characters are quite constant.

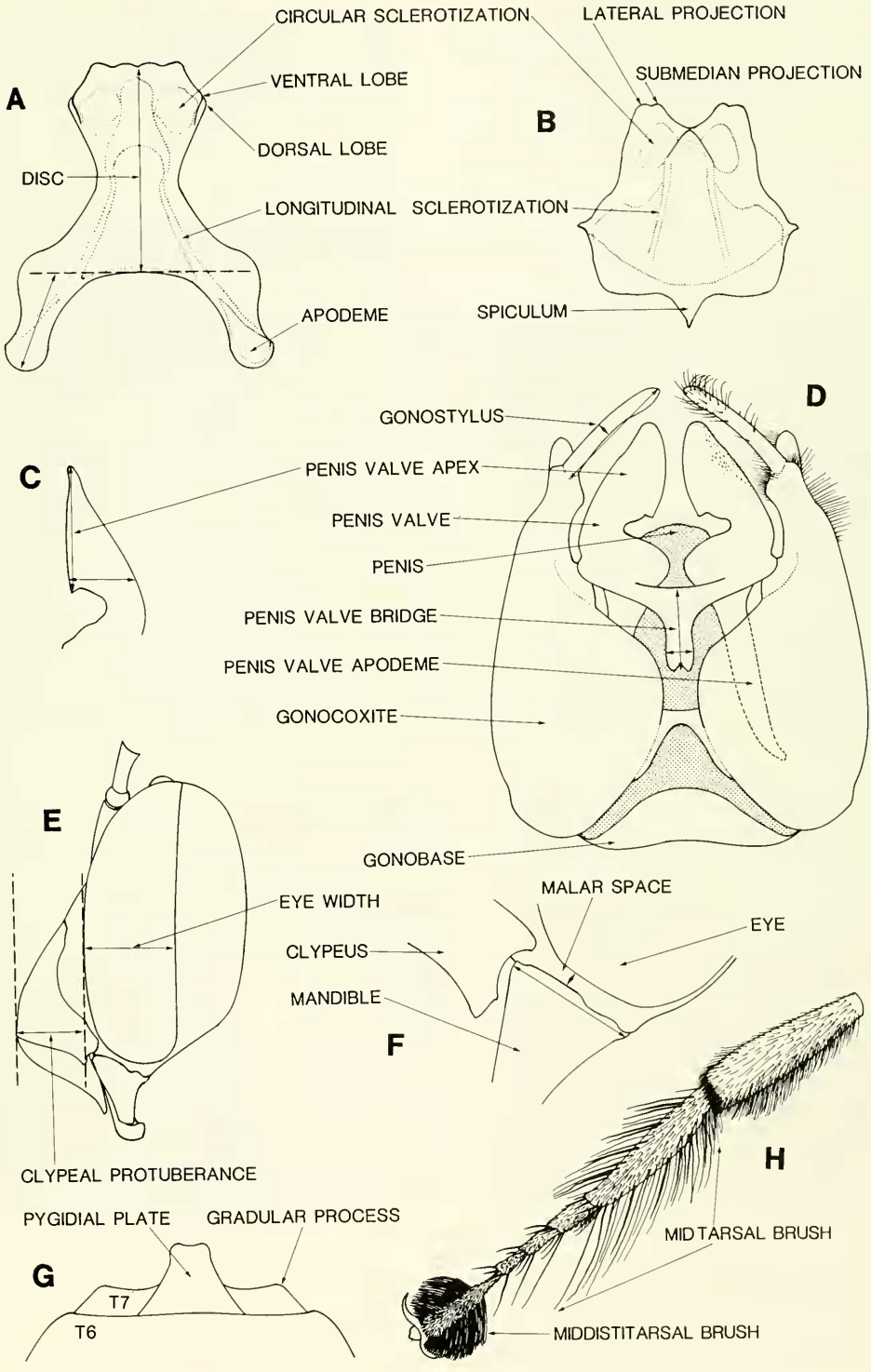
The subgeneric classification of *Anthophora* presented in the next section is based on the lettered groups of characters listed below. This list serves to explain the terminology used in keys and descriptions.

Head. (a) The flagellomeres were measured from lateral view along their midlines. The length of *flagellomere 1* relative to the succeeding flagellomeres is especially useful to separate females. Some subgenera are characterized by a long first flagellomere which equals in length the next four to five or more flagellomeres (Fig. 7a). Other subgenera have a short first flagellomere, equaling in length only the next two to three together (Fig. 7b). (b) Pale *integumental facial markings* are almost always present in male Anthophorinae and females of *Amegilla,* but are rare in female *Anthophora.* The *mandible* almost always has a subapical tooth. (c) The *malar space* normally is linear (Fig. 2f), that is, four to five or more times as wide as long. In bees with a strongly protuberant clypeus and long mouthparts, however, the malar space is often prolonged (Figs. 25h, 26c), sometimes as much as twice as wide as long. The method for measurement of the clypeal protuberance compared to the eye width is shown in Figure 2e. The glossal *flabellum* has long finger-like apical lobes (Fig. 16b) in almost all *Amegilla* and most *Anthophora.* In some subgenera of *Anthophora,* however, the shape of the flabellum is diagnostic, being more elongate with numerous short apical lobes (Fig. 26b) or apically entire (Figs. 12j, 25d). In almost all *Anthophora* the mentum is simple without an anterior tooth on the basal third, but the subgenus *Melea* (Fig. 22k), a species of *Dasymegilla,* and almost all *Amegilla* (except *A. nonconforma* n. sp.) have that tooth.

Thorax. (d-f) Some male *Anthophora* have three kinds of pubescent fringes or "brushes" of hair on their midlegs (Fig. 12c). The *midbasitarsal brush* is a dense patch of short black pubescence on the anterior apical surface of the basitarsus. The *midtarsal brush* is a long loose fringe of pale to dark hair on the posterior surfaces of tarsomeres 1-4. The "fan" or fringe of black hair on the lateral margins of the distitarsus is the *middistitarsal brush.* (g) The *hind basitarsus* of males is usually unmodified, but sometimes a basal to apical tooth is present on the anterior surface (Figs. 20j, 20o). Occasionally the *hind tibia* has an apical spine on its anterior surface (Fig. 41e), the outer tibial spur being inserted on the spine in various positions. The hind tibial *scopa* of females consists of simple hairs on the outer surface of the hind tibia. The *posterior margin of the hind tibia* is the narrowed rear area of the hind tibia from its base to apex. The hairs on the posterior margin of the hind tibia of *Anthophora* are simple, like the rest of the tibial scopa, in some subgenera (Figs. 10e, 22h) but plumose, in contrast to the rest, in most. (h) The *basitibial plates* are present in all females and many male anthophorine bees. They are small, roughened and devoid of hair when present in the males.

Metasoma. (i) *S6* of male is usually apicomedially emarginate (Figs. 13a, 16f, 18f) and generally covered sparsely with plumose hair. Its apodemes have well developed apical processes. The ventral surface is modified in various ways such as by protuberances, depressions and ridges. (j) *S7* of male usually has long apodemes. The method of finding the ratio of the length of the apodeme to the length of the disc is shown in Figure 2a. The apex of the sternum is variously modified. The lateral margin can have a *ventral lobe* and proximal to it a *dorsal lobe;* medial to the lobes there may be a lightly sclerotized area, the *circular sclerotization,* and running longitudinally, a darkened line, the *longitudinal sclerotization* (Fig. 2a). (k) *S8* of male is apically narrow to broad. Sometimes on the apicolateral corner there may be two lobes, the *submedian projection* and the *lateral projection,* as well as longitudinal sclerotizations (Fig. 2b). The *spiculum* is always present, usually dorsally directed (Fig. 24h). In one subgenus of *Anthophora* the spiculum is long and anteriorly directed, more or less in the same plane as the disc (Fig. 25b). (l) The *apex of the gonocoxite* of the male is heavily sclerotized and variously modified with one to three lobes. It always bears setae,

FIG. 2. Morphological terms and measurements. Hair omitted in E and G. A-D, G, H, *Anthophora (Pyganthophora) crotchii* male; E, F, *A. (Paramegilla) centriformis* male. A, S7, ventral view, showing how length of disc and apodeme were measured. B, S8, ventral view. C, Dorsoapical view of apex of penis valve, measurement shown of length/width ratio. D, Genital capsule, dorsal view. E, Head, side view, showing how clypeal protuberance/eye width ratio was measured. F, Ocular mandibular area, showing how length of malar space was determined. G, Apex of male metasoma, dorsal view. H. Midleg, outer view.


A
CIRCULAR SCLEROTIZATION
VENTRAL LOBE
DORSAL LOBE
DISC
LONGITUDINAL SCLEROTIZATION
APODEME
B
LATERAL PROJECTION
SUBMEDIAN PROJECTION
SPICULUM
C
PENIS VALVE APEX
D
GONOSTYLUS
PENIS VALVE
PENIS
PENIS VALVE BRIDGE
PENIS VALVE APODEME
GONOCOXITE
GONOBASE
E
EYE WIDTH
CLYPEAL PROTUBERANCE
F
MALAR SPACE
EYE
CLYPEUS
MANDIBLE
G
PYGIDIAL PLATE
GRADULAR PROCESS
T7
T6
H
MID TARSAL BRUSH
MIDDISTITARSAL BRUSH

usually plumose ones. (m) Each gonocoxite bears only a single, narrow, usually elongate *gonostylus* which is always setose and almost always only slightly sclerotized. Sometimes it is reduced to a blister or is lost. Figure 2d demonstrates how I measure the length and width of the gonostylus. (n) The *penis valve apex* is gently rounded, never with an apical crest, and always bears minute setae on its dorsal surface. Viewing the apex apicodorsally, the length is measured along the inner margin and the width is taken at a 90 degree angle to the length, measuring at the base of the penis valve apex (Fig. 2c). (o) The *penis valve bridge* (its measurement shown in Fig. 2d) is usually basally emarginate. In one subgenus of *Anthophora,* however, the bridge is basally acute, and in another almost absent. (p) The male *pygidial plate* (Fig. 2g) is often present. Just as often the apex of T7 bears two submedian teeth and lacks a pygidial plate (Fig. 18j). Occasionally the gradulus of the male T7 is prolonged laterally into a gradular process, which can be blunt (Fig. 2g) to acute (Fig. 30g). A *gradular process* may also be present on T6 and rarely on T5. (q) Usually

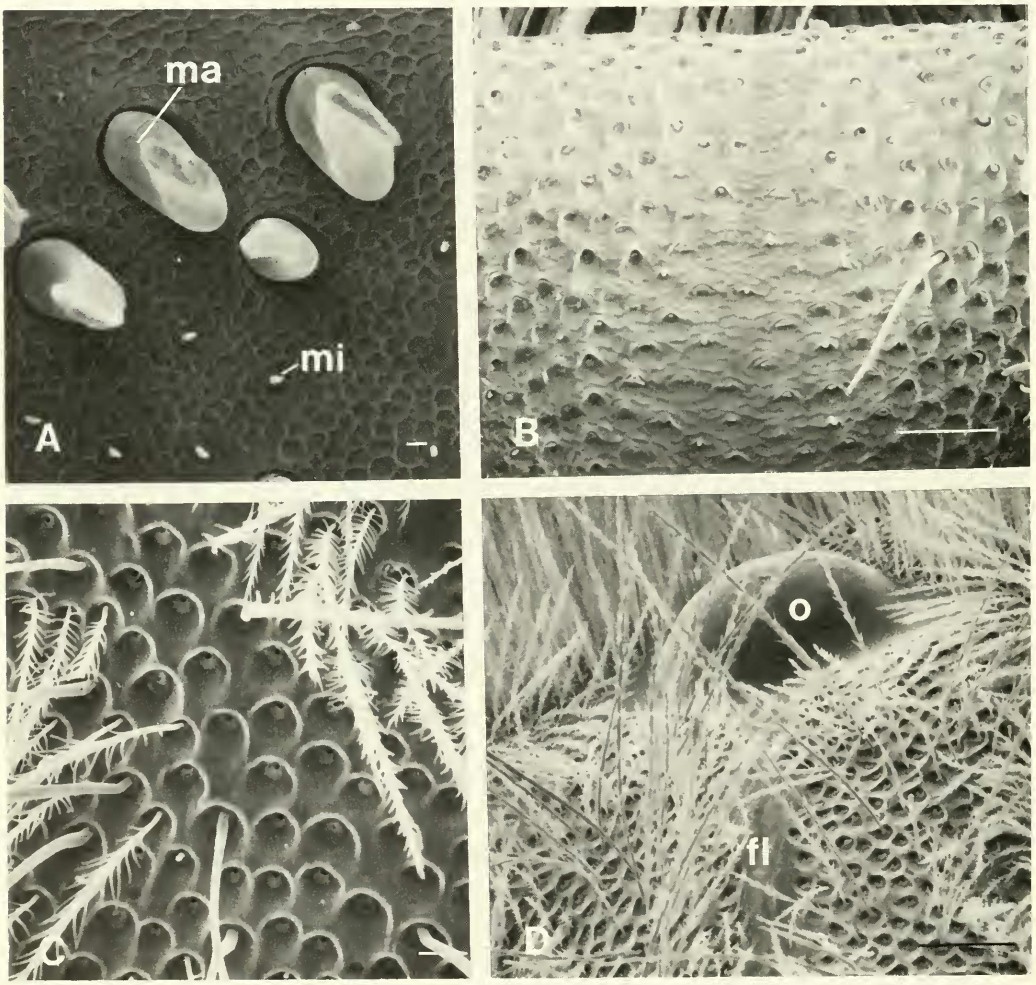


FIG. 3. Sculpturing commonly found in anthophorine bees. Scale line represent .01 mm in A and C, .1 mm in B and D; ma = macroseta, mi = microseta, fl = frontal line, o = median ocellus. A, *Anthophora (Mystacanthophora) incerta* female, clypeus with microareolate sculpturing. B, *A. (Heliophila) vestita* female, vertex of head (with hairs broken off) showing punctate sculpturing laterally grading into puncticulate medially, ground between punctures microareolate. C, D, *A. (Heliophila) bimaculata* male, supraclypeal area showing punctate-reticulate sculpturing, and ocellar region with rugulose-lacunose sculpturing shown on either side of frontal line.

the *first recurrent vein* of the forewing joins submarginal cell 2 at or slightly distal to the midpoint on the posterior margin of the cell. It is never interstitial with the first transverse cubital vein (Fig. 4a). (r) The *sting* is 2-3 times longer than the gonostylus.

Body length is measured in dorsal aspect from the apex of the clypeus to the apex of the metasoma; it is 6-24 mm.

TRIBE ANTHOPHORINI DAHLBOM

Podalirii Latreille, 1802a, p. 377.
Anthophorini Dahlbom, 1835, p. 5.
Megillina Thomson, 1869, p.7.

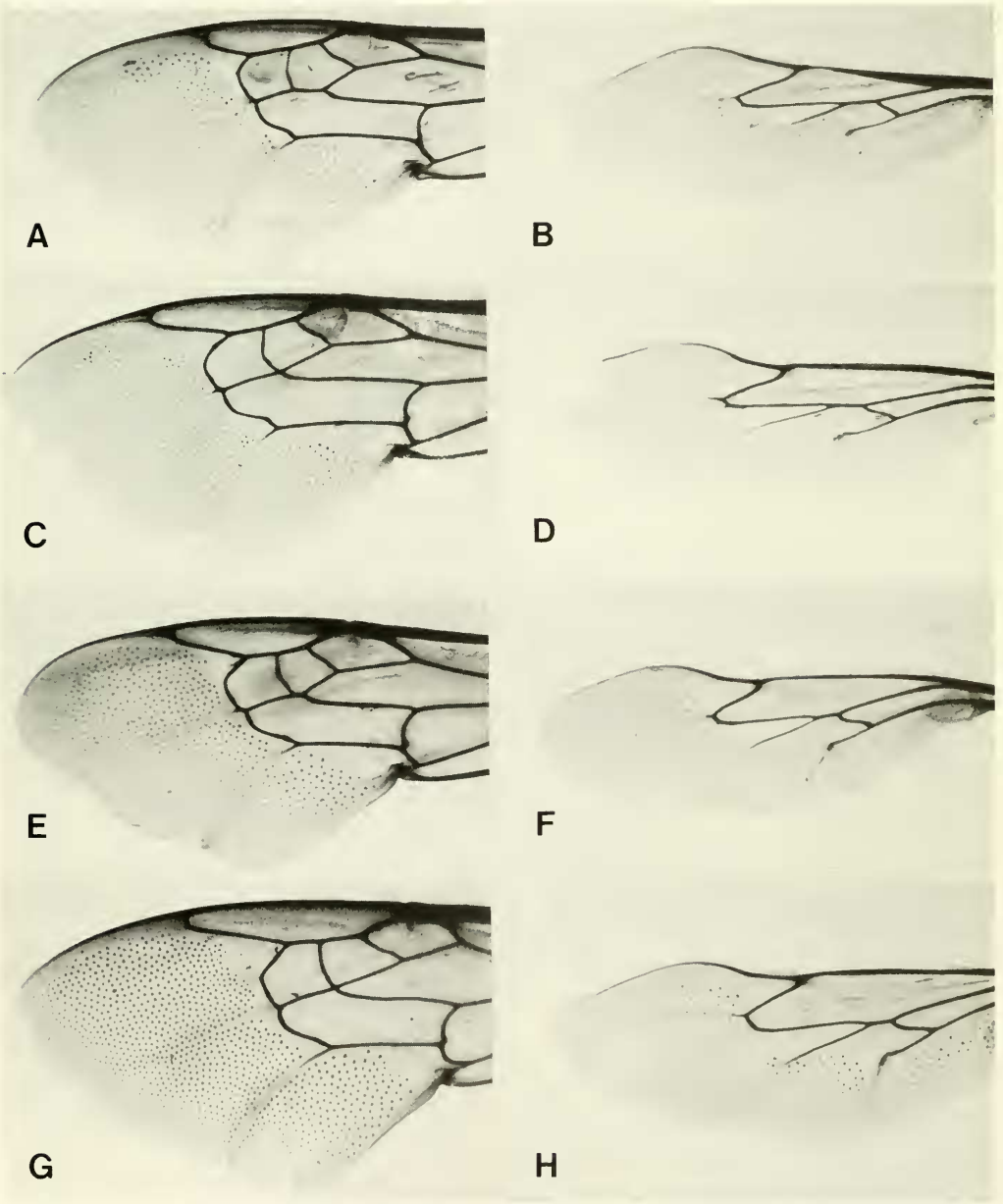


FIG. 4. Fore (A, C, E, G) and hind wings (B, D, F, H) of anthophorine and habropodine bees. A, B, *Anthophora plumipes*. C, D, *Habropoda tarsata*. E, F, *H. tristissima*. G, H, *Pachymelus conspicuus*.

Diagnosis. Bees of small to large size, differing from Habropodini as follows: first recurrent vein joining posterior margin of submarginal cell 2 near midpoint, never interstitial with vein between submarginal cells 2 and 3 (Fig. 4a); anterior and posterior margins of submarginal cell 3 more nearly equal in length; marginal cell short, shorter than combined lengths of submarginal cells along their posterior margins (Fig. 4a); spatha absent; gonostylus of male never paddle shaped, one gonostylus per gonocoxite; apex of S7 of male never pointed but entire to emarginate; S6 of male not strongly convex medioapically; scopal hair simple except on posterior margin of hind tibia usually plumose (Figs. 10a-c), sometimes simple (Fig. 10d-e).

Description. a. Body length 6.0-24.0 mm. b. Flagellar segment 1 of female equal to combined lengths of next 2.0-5.5 flagellomeres; of male, to next 1.0-4.2 flagellomeres. c. Face of male almost always with white to yellow integumental markings, rarely all black; face of female with or without white to yellow integumental marking; mandible almost always with subapical tooth; clypeus protuberant to relatively flat, profile projecting 0.3-1.2 width of eye; labrum usually apically simple, margin thickened; maxillary palpus usually with six segments, sometimes five or four; labial palpus almost always with four segments, sometimes three or two; mentum usually without a pair of teeth on anterior basal third, length 0.5-0.9 length of prementum; paraglossal length equal to 0.5-1.2 length of stipes; lorum almost always Y-shaped. d. Malar space of male and female 1.0- 16.0 times wider than long. e. Midtibia of male sometimes with various brushes of hair (Figs. 12c, 13j, 18k). f. Hind basitarsus of male sometimes with tooth, ridge, and/or swollen; hind tibia of female with simple scopal hairs, though usually with a narrow posterior longitudinal zone of plumose hair. g. Arolia present except in *Amegilla.* h. Basitibial plate of male present to absent. i. S6 of male generally flat except for lateral margin, medioapically emarginate to entire, rarely produced, disc variously modified with depressions, protuberances, or ridges; S4 and 5 of male usually normal, rarely modified. j. S7 of male with disc apically emarginate to bluntly produced, laterally simple or with one to two lobes, length of apodeme 0.24-1.75 length of disc. k. S8 of male apically narrow to broad, with two small submedian lobes whose length is at most one-fifth length of disc. l. Apex of gonocoxite of male variously modified, simple, bilobed or trilobed. m. Gonostylus of male elongate and narrow to greatly reduced to absent, never flattened and leaf-like. n. Penis valve apex is slender and long to wide and short; sometimes apically hooked. o. Penis valve bridge present, spatha absent (very weakly developed in a few rare cases). p. T7 of male either with two subapical teeth or pygidial plate; pygidial plate of female with margin simple or carinate. q. First recurrent vein of forewing joining submarginal cell 2 near midpoint, never meeting first r-m. r. Hind wing with cu-v subequal to second abscissa of M + Cu; cu-v slanted from M + Cu basad; vein M about three times length of second abscissa of M + Cu. s. Jugal lobe one-third or less length of vannal lobe. t. Wings essentially bare with well developed alar papillae.

Distribution. The tribe Anthophorini with about 600 species is one of the largest tribes in the family Anthophoridae, second perhaps only to the tribe Eucerini. Members of this tribe are found in the tropical and temperate zones of the world with particular abundance in xeric areas such as the southwestern United States, Mediterranean region, northern and eastern Africa and Australia.

Biology. These bees are swift flyers. Almost all of them nest in the ground, preferably in banks; a few nest in wood [subgenus *Clisodon* and perhaps *Anthophora (Anthophoroides) signata*]. Sometimes more than one species will nest at the same site (Schneider, 1982). I have seen *A. bomboides* and *abrupta* share the same nest site at Lawrence, Kansas [this was also noted at St. Louis, Missouri (Rau, 1926) and Baltimore County, Maryland (Norden and Scarbrough, 1982)] and *A. bomboides* and *californica* at Point Reyes National Seashore in California. Anthophorine bees commonly reuse the same nest site year after year, unlike many other bees. When the nesting substrate is displaced from the original location, bees may be attracted to it (Michener, 1960), suggesting that there is some chemical nesting marker that serves as a lure. Perhaps this is one reason why more than one species can be found occupying a single nest site.

Earthen (or saw dust in the case of *Clisodon*) cells are lined with wax and provisioned with a semi-liquid mass of pollen, nectar and Dufour's gland secretion (Norden et al., 1980). The wax lining and provisions give off a strong cheesy odor (Malyshev, 1925) from butyric acid, a product of the triglycerides of the Dufour's gland and probably salivary or gut enzymes (Norden et al., 1980) and is soluble in many solvents (Batra, 1972). The cell linings are thick and similar to those of habropodine bees. Compared to those of Habropodini, anthophorine cell linings are not thicker or do they differ in their separability from the cell wall; furthermore, there is no difference in burrow orientation, contrary to Marikovskaya (1976a).

The mandibular gland secretion may function as an alarm or aggregation pheromone in certain species of *Anthophora,* since netted females give off a mandibular gland secretion attracting other females by the hundreds (Thorp, 1969; Brooks, 1983; Batra, 1984). Some species have males which defend territories (Brooks, 1983) and females which vigorously defend their nests against parasitic bees (Batra, 1978).

Polylecty is generally the rule, as exemplified by *Anthophora plumipes* (cited under *A. acervorum*)

(Ruszkowski, 1966) and various species of Indian Anthophorini (Batra, 1967). Only two species are known to be narrowly oligolectic; they are *Anthophora phaceliae* n. sp. whose females visit almost exclusively various species of *Phacelia* (Hydrophyllaceae) (Brooks, unpublished) and *Amegilla (Glossamegilla) florea* which in Japan visits only *Impatiens textori* (Miyamoto, 1962).

The nesting behavior of *Amegilla* is as in species of *Anthophora*. Some species of the subgenus *Asaropoda* nesting in flat ground construct turrets over their nest entrances (Rayment, 1951; Michener, 1965). *Amegilla* flies generally in the summer, whereas species of *Anthophora* are generally active in the spring. Many species of *Amegilla* in the Mediterranean region are diminutive and superficially resemble species of *Anthophora* subgenus *Heliophila*.

Taxonomy. Numerous keys have been made to the adults of anthophorine genera; the most important covering North America are by Michener (1944), Mitchell (1962, only Eastern U.S.), Stephen et al. (1969); India (Batra, 1977), Europe (Friese, 1897; Schmiedeknecht, 1930), Egypt (Priesner, 1957), and European U.S.S.R. (Osychnyuk et al., 1978). Keys and descriptions

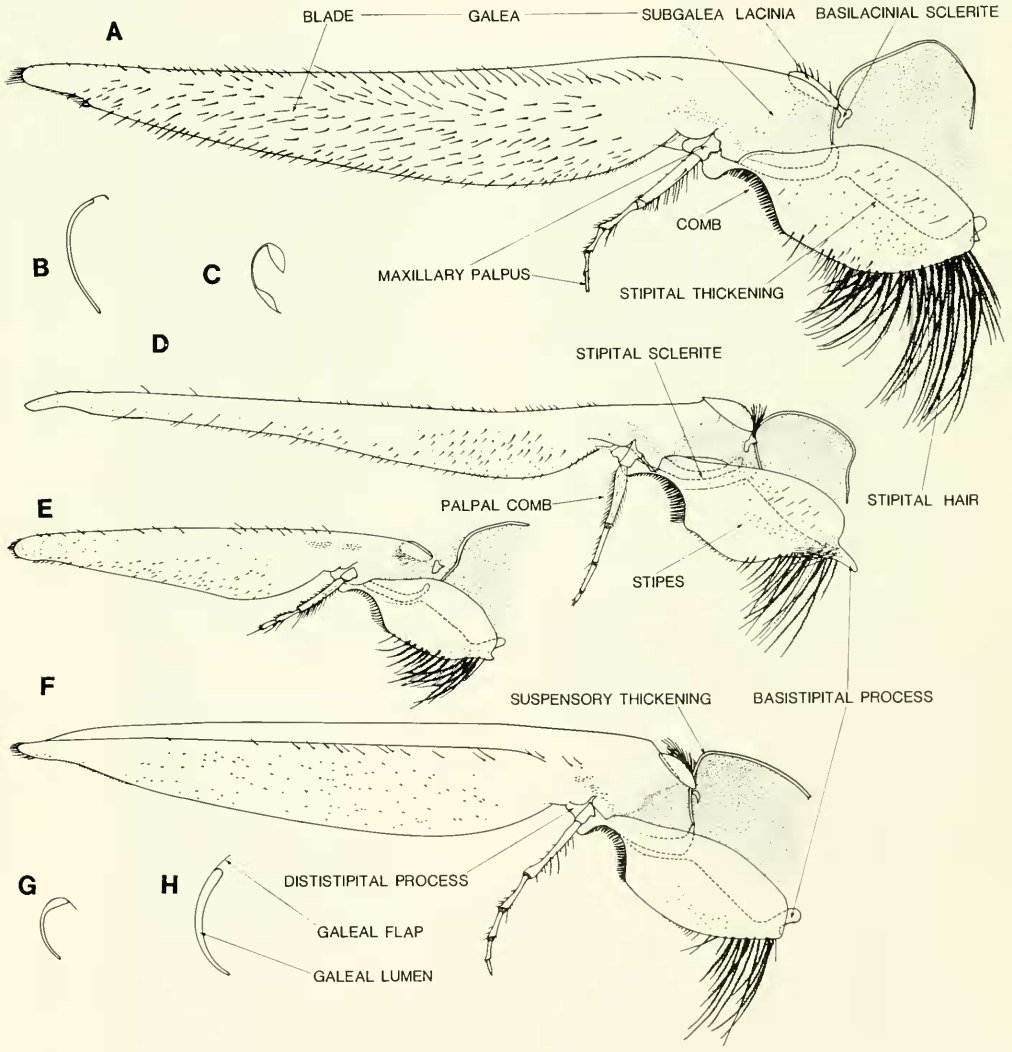


FIG. 5. Maxillae, outer views. A, B, *Anthophora (Anthophora) plumipes,* maxilla and cross section of galea at midlength. C, D, *Amegilla (Amegilla) quadrifasciata,* cross section of galea at midlength and maxilla. E, G, *Anthophora (Heliophila) bimaculata,* maxilla and cross section of galea at midlength. F, H, *Anthophora (Clisodon) terminalis,* maxilla and cross section of galea at midlength.

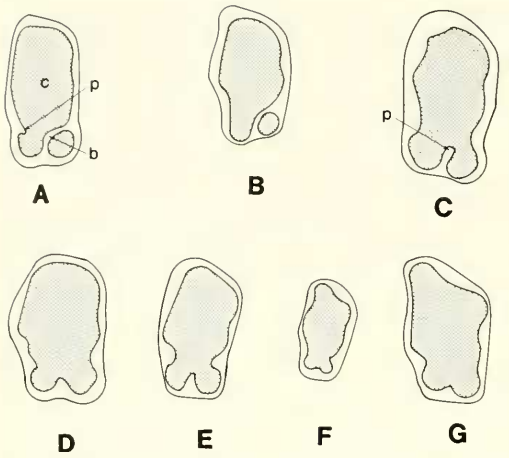


FIG. 6. Apices of female hind tibiae, apical views. Dotted areas indicate internal space. Acetabulum and tibial spurs omitted. Tibiae are oriented such that the outer and anterior surfaces are on the right and bottom, respectively. Tibial spurs would be attached in lower part of each drawing. b = exoskeletal bridge, c = internal space, p = exoskeletal process. A, *Amegilla (Amegilla) quadrifasciata*. B, *A. (Zonamegilla) comberi*. C, *A. (Glossamegilla) violacea*. D, *A. (Asaropoda) bombiformis*. E, *Anthophora (Anthophora) plumipes*. F, *A. (Heliophila) cockerelli*. G, *A. (Melea) occidentalis*.

of larval Anthophorini are given by Michener (1953), McGinley (1981) and Torchio and Stephen (1961).

Unplaced Species

The following species cannot be placed with certainty into the Anthophorini since the types are either lost or destroyed (all originally described in the genus *Anthophora* unless indicated otherwise): *Apis bihamata* Panzer, *citreostrigata* Dours, *Megilla excelsa* Gistel, *frontata* Say, *Apis incisa* Fourcroy, *luteodimidiata* Dours, *marsupoda* Christ, *mediozonata* Laboulbene, *melanopyrrha* Dours, *mexicana* Dours, *nigroaeruginosa* Dours, *ornata* Gistel, *pilosa* Lespes, *pluto* Dours, *pulsella* Dours, *pygmaea* Dours, *pyropyga* Dours, *pyrozonata* Dours, *repleta* Dours, *rufozonata* Dours, *Apis seminuda* Fabricius, *Megilla senilis* Illiger, *simia* Dours, *spodia* Dours, *tunicata* Gistel, *uniciliata* Sichel, *unistrigata* Dours and *volucellaeformis* Dours.

Anthophorini incertae sedis

The following species are either *Anthophora* or *Amegilla*. They cannot be placed with certainty in either genus since the types are lost or destroyed (in a few cases the types exist but have not been studied yet; all were originally described in *Anthophora* unless otherwise indicated): *alpatovi* Kuznetzov-Ugamsky, *angulosa* Hedicke, *annulifera* Walker, *cellularis* Cameron, *combusta* Dours, *dalmatiensis* Strand, *Megilla excelsior* Strand, *ferruginata* Lepeletier, *germabica* Radoszkowsky, *hastula* Vachal, *illepida* Walker, *imitatrix* Cockerell, *iranica* Hedicke, *jakobsoni* Kuznetzov-Ugamsky, *kuzini* Kuznetzov-Ugamsky, *laevigata* Spinola, *lepidodea* Dours, *leucomelaena* Dalla Torre, *leucosticta* Hedicke, *lutescens* Walker, *melaleuca* Lepeletier, *padiola* Vachal, *pallescens* Morawitz, *pauperata* Walker, *plagioleuca* Hedicke, *plebeja* Morawitz, *sauteri* Friese, *semenovi* Kuznetzov-Ugamsky, *semicinerea* Dours, *senex* Smith, *tekkensis* Gussakovsky, *variipes* Morawitz and *Megilla vetula* Klug.

Key to Genera of the Anthophorini

1. Arolia present, well developed (Fig. 9a); basistipital process with two projections (Figs. 5a, e, f); mentum simple or with anterior tooth on basal third (Fig. 22k); gonostylus almost always present and well developed; hair never metallic. . . . . *Anthophora*
— Arolia absent (Fig. 9c); basistipital process with one projection (Fig. 5d); mentum almost always with a single anterior tooth on basal third; gonostylus often greatly reduced to absent; hair sometimes metallic . . . . *Amegilla*

Genus *Anthophora* Latreille

Diagnosis. Arolia present (9a); hind leg of male often modified with teeth, midleg of male often

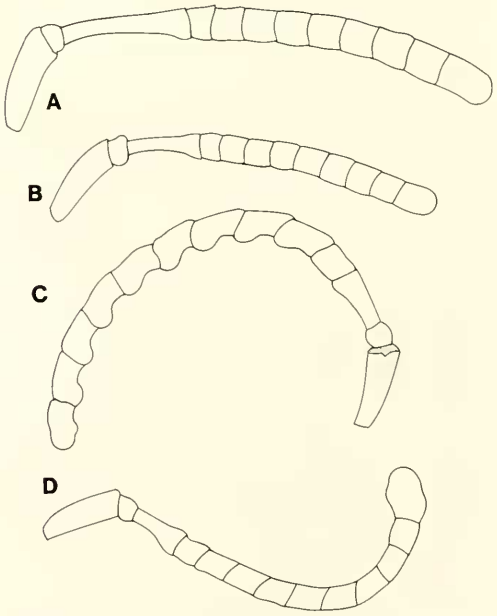


FIG. 7. Antennae of *Anthophora*. A, *A. (Lophanthophora) pacifica* female. B, *A. (Anthophoroides) californica* female. C, *A. (Paramegilla) astragali* male. D, *A. (Paramegilla) clavicornis* male.

with brushes; pubescence never blue or metallic, metasoma generally with shaggy hair, sometimes appressed; outer hind tibial spur not to only partially isolated from inner tibial spur [(Figs. 6e-g) see *Comments* under *Amegilla*]; anterior surface of mentum near basal third almost always without tooth; galea with a single, not "double," lumen (Figs. 5b, g, h).

Description. a. Body length 6.0-24.0 mm. b. Flagellar segment 1 of female equal to combined lengths of next 2.2-5.5 flagellomeres; of male to next 1.0-4.2 flagellomeres. c. Face of male with yellow to white integumental marking, rarely all black, of female all black, sometimes with pale integumental marking; clypeus protuberant at least .7 width of eye in profile (except *Mystacantho-phora*); labrum of male usually apically simple, occasionally trilobed (as in *Anthomegilla, Dasymegilla, Petalosternon,* weakly in *Clisodon* and some *Pyganthophora* and *Rhinomegilla*), labial palpus with four segments [except *A. (Paramegilla) fulvicauda* with three, *A. (Heliophila) hololeuca* with two]; mentum .5-.8 length of prementum, sometimes with an anterior tooth on basal third [as in *Melea, Anthophoroides,* and *A. (Dasymegilla) excisa*]; paraglossal length equal to .5-.9 length of stipes; galea with a single lumen (Figs. 5b, g, h). d. Midtarsal brush of male present [as in *Anthophora* s. str., *Lophanthophora,* and *Pyganthophora* (Figs. 2h, 12c)] or absent. e. Midbasitarsal brush of male present [as in *Anthophora* s. str., *Lophanthophora, Pyganthophora,* and *Caranthophora*) (Figs. 12c, 13j)] or

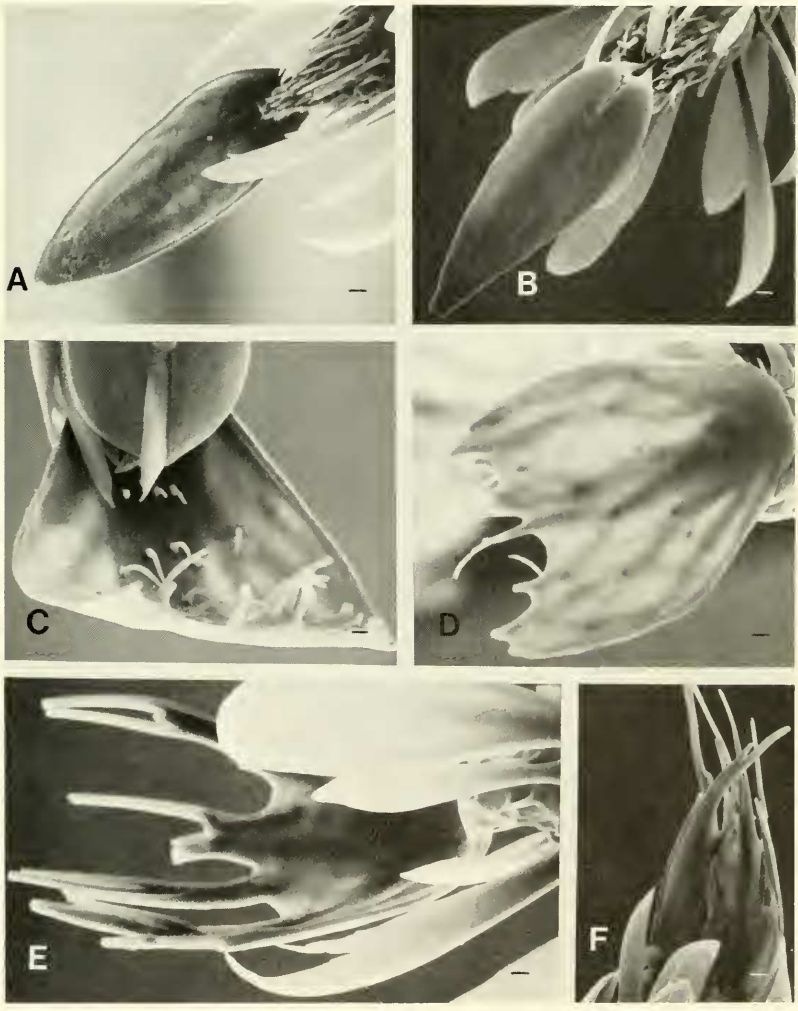


FIG. 8. Flabella. Scale lines represent .01 mm. A, B, *Anthophora (Anthophora) plumipes,* anterior and posterior views. C, D, *A. (Melea) abrupta* apicoanterior and posterior views. E, F, *Amegilla (Amegilla) quadrifasciata,* posterior and anterior views.

absent. f. Middistitarsal brush of male present [as in *Anthophora* s. str., *Lophanthophora, Pyganthophora,* and *Caranthophora* (Figs. 2h, 12c, 18k)] or absent. g. Hind basitarsus of male simple, almost parallel-sided or modified with an anterior weakly developed protuberance to a well developed tooth or longitudinal ridge, tarsus sometimes elongated (Fig. 20j); hind tibia of female with simple scopal hairs except posterior margin plumose (Figs. 10a, c) [posterior margin with simple hairs in *Anthomegilla, Clisodon, Melea, Rhinomegilla* and *Heliophila* (Fig. 10d, e)]. h. Apodeme of S7 of male short to long, 0.30-1.75 length of disc. i. Apex of gonocoxite of male with various modifications such as simple, bilobed or trilobed in profile, with or without lamellate carinae. j. Gonostylus of male short [as in *A. (Paramegilla) gracilipes*] to long (as in many *Lophanthophora*), 2-20 times longer than wide, flattened to round in cross section, possibly absent in a few species. k. Penis valve apex, as viewed apicodorsally, short to long and thick to thin, 0.9-4.5 times longer than wide (Fig. 2d). l. Penis valve bridge basally projecting (basal projection absent in *Anthomegilla*), basally entire to deeply emarginate, apically round (apically acute in *Rhinomegilla*), length 0.7-3.1 times as long as wide. m. Pygidial plate of male present [as in *Lophanthophora, Pyganthophora,* and most *Paramegilla* (Figs. 2g, 13c, 15c, 20h, i, k-n)] and sometimes with lateral tooth [some *Paramegilla* and *Lophanthophora* (Figs. 20h, i, k-m)] or when plate absent pygidium modified medioapically with two obtuse to acute teeth, with a median longitudinal ridge [*Anthomegilla, Rhinomegilla, Heliophila* and some *Paramegilla* (Figs. 19d, 25j, 26f)], actual apical margin flexed ventroanteriad [greatly so in *Dasymegilla* (Fig. 27f)]; gradular process of male T7 sometimes present [e.g., *Lophanthophora, Heliophila* and some *Pyganthophora* (Figs. 13c, g, 15c)]; pygidial plate of female with margin usually carinate, never with median longitudinal ridge but flat or gently convex, striate.

Distribution. Anthophora is found on all biogeographic areas except Australia, the Indomalaysian region and Madagascar. It is uncommon in Southeast Asia where only a few species of four subgenera are found. Three subgenera are subsaharan and only one is primarily neotropical.

Morphology. The morphology of adult and larval *Anthophora* was exhaustively illustrated and discussed by Michener (1944, 1953). Almeida Correia (1973) and Saunders (1891) illustrated the mouthparts of *Anthophora,* and more recently Michener and Brooks (1984) described its glossa.

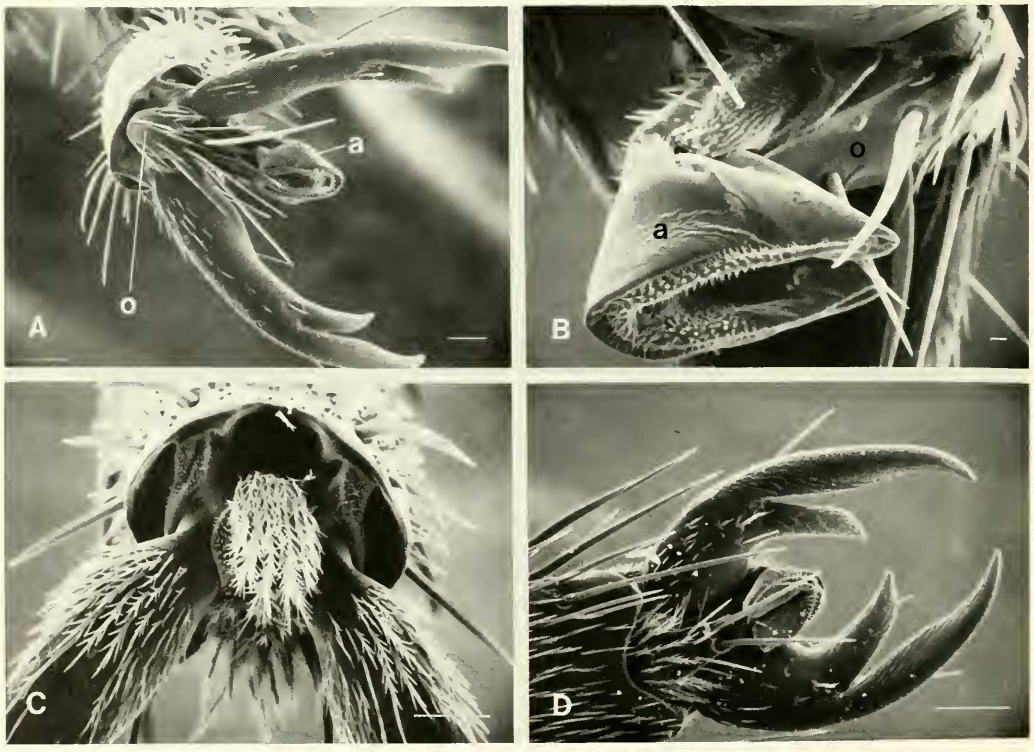


FIG. 9. Hind claws and arolia of females. Scale lines (on right side) represent .1 mm in A, C, D and .01 mm in B; o = orbicula, a = arolium. A, B, *Anthophora (Melea) abrupta,* dorsal and apical side views. C, *Amegilla (Amegilla) quadrifasciata,* dorsal view. D, *Anthophora (Mystacanthophora) arequipensis,* dorsal view.

The Dufour's gland was first illustrated by Trojan (1930). Brooks (1983) illustrated the terminalia of the New World species groups. Apomorphic characters for the genus are shown in the cladogram (Fig. 40).

KEY TO SUBGENERA OF *ANTHOPHORA*

1. Seven exposed metasomal terga; thirteen antennal segments; males 2
— Six exposed metasomal terga; twelve antennal segments; females 17
2. Midtarsus with middistitarsal brush (Fig. 2h), usually with midbasitarsal brush also (Fig. 12c); apex of S7 laterally with two lobes, a ventral and

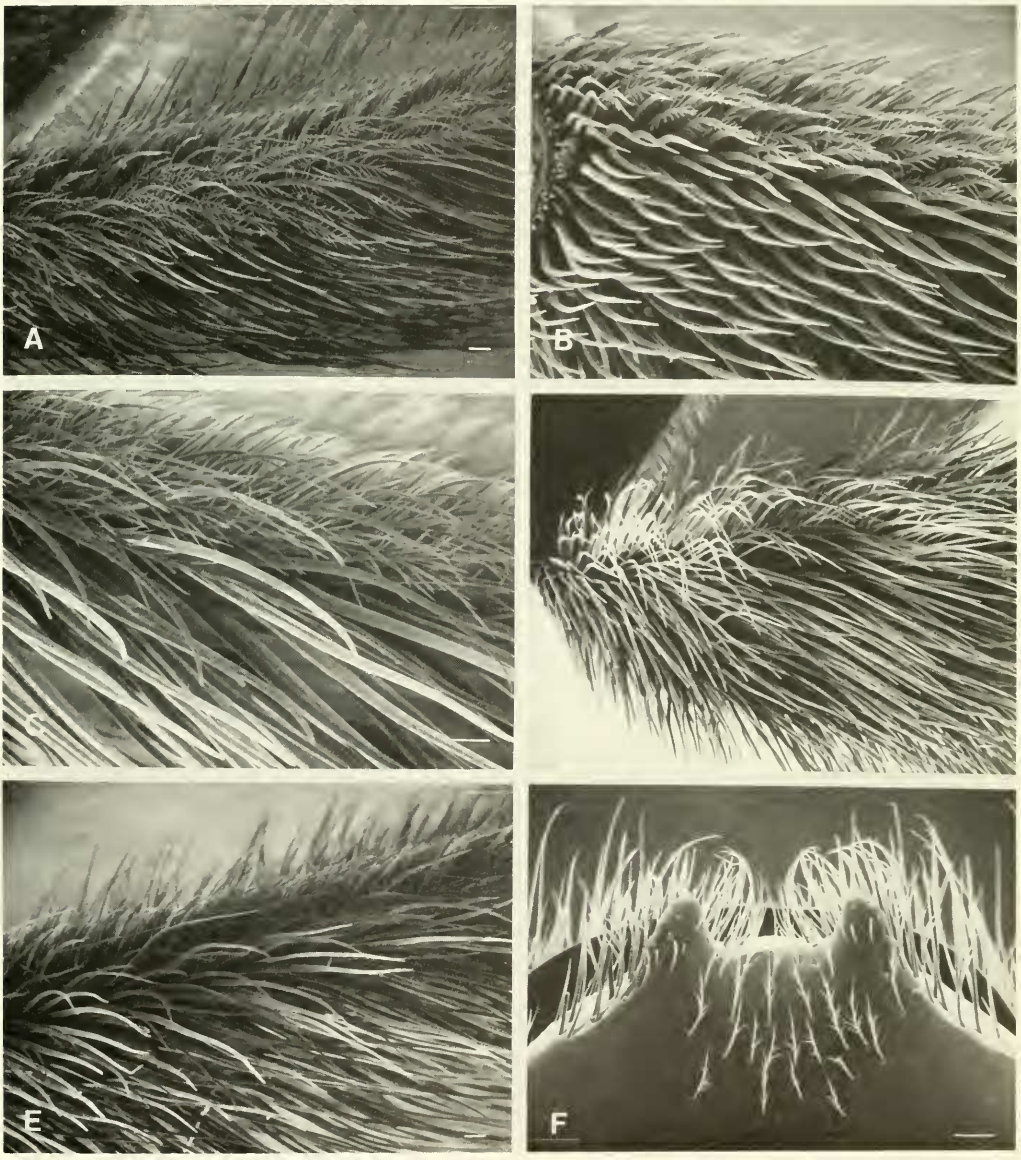


FIG. 10. A-E, Outer views of hind tibiae of females to show vestiture. A-C show band of plumose hairs along posterior margin of tibia, D and E lack such hairs. Scale lines (on lower right side) represent .1 mm. A, *Anthophora (Anthophora) plumipes.* B, *Amegilla (Amegilla) quadrifasciata.* C, *Anthophora (Mystacanthophora) capistrata.* D, *A. (Heliophila) bimaculata.* E, *A. (Melea) abrupta.* F, Ventral view of T7, *A. (Heliophila) bimaculata.*

dorsal one (Fig. 2a) 3
— Midtarsus simple, without any brushes; apex of S7 laterally simple (Figs. 16g, 19e, 20d, 22e) or with two lobes (Fig. 2a) 6
3. Basitibial plate absent; pygidial plate absent 4
— Basitibial plate present; pygidial plate present 5
4. Flabellum apically entire (Figs. 8a, b, 12j); S7 apically narrowed, elongate, apodemes at least 1.3 times as long as length of disc (Fig. 12n); apex of gonocoxite deeply bilobed (Figs. 12f-h) . . . . . *Anthophora*
— Flabellum apically with finger-like projections (Figs. 8d); S7 apically broad, short, apodemes no more than 0.4 times as long as length of disc (Fig. 18d); apex of gonocoxite weakly trilobed (Fig. 18a). . . . . *Caranthophora*
5. Distal half of S6 with a pair of apically diverging oblique ridges (Fig. 14d); apex of gonoxite simple, flattened, hooked ventrad (Figs. 14a, b) . . . . . *Lophanthophora*
— Distal half of S6 simple, without ridges (Fig. 13a); apex of gonocoxite bilobed or triangular, not flattened and hooked ventrad (Figs. 13b, d, l-n) . . . . . *Pyganthophora* (in part)
6. Mandible bidentate, sometimes simple; gonostylus lightly sclerotized, thus clearly demarcated from apex of gonocoxite; flabellum apically with finger-like lobes (Fig. 8c) 7
— Mandible tridentate; gonostylus concolorous with apex of gonocoxite, perhaps absent; flabellum apically simple (Figs. 29c, d) . . . . . *Clisodon*
7. Mentum with an anterior tooth near basal third (Fig. 22k); hind basitarsus with anterior tooth or strong ridge (Figs. 22i, 24i, j); apex of S7 with one lateral lobe (Figs. 22e, 24d) 8
— Mentum simple without anterior tooth near basal third (if a single tooth present then hind basitarsus simple, almost parallel-sided and without anterior tooth or ridge); hind basitarsus variable; apex of S7 with two lateral lobes, sometimes only weakly developed (Figs. 25e, 26d); if apex simple laterally or with one lobe, then body small (7.5- 13.5mm) and/or S6 with thick pad of hair (Figs. 30a, 32b) . . 9
8. Length at most 13 mm; hind tibia having apical spine with a tibial spur inserted near spine's apex (Figs. 24j); apex of gonocoxite heavily sclerotized (seen only in cleared preparation of genital capsule) with a distinct melanized demarcation between apex and base (Fig. 24f); face with white integumental markings (yellow in *A. vallorum* and *californica*) . . . . . *Anthophoroides*
— Length greater than 13 mm; hind tibia simple, without apical spine (Fig. 22i); apex of gonocoxite not more heavily sclerotized than base, no demarcation between the two (Fig. 22c); face with yellow integumental markings . *Melea*
9. Malar space long, more than one-third as long as wide (Figs. 25h, 26c); flabellum apically entire, elongate with apical two-thirds narrowed (Fig. 25d) or flabellum with numerous small apical lobes (Fig. 26b) 10
— Malar space almost always short and linear, at most one-third as long as wide (Fig. 1b); flabellum short and wide, apically with three to ten finger-like projections (Fig. 8e) or if entire, then apical two-thirds not narrowed and flabellum not with numerous, short apical lobes; S6 almost always medioapically emarginate (Figs. 30a, g) 11
10. Flabellum apically entire, elongate with apical two-thirds narrowed (Fig. 25d); pygidium of male with longitudinal median ridge not reaching apex, with two small submedian, weakly developed projections (Fig. 25j); penis valve bridge short, basally emarginate (Fig. 25f) . . . . . *Anthomegilla*
— Flabellum apically with numerous small lobed divisions, broom-shaped, and lateral margins almost parallel (Fig. 26b); pygidium apicomedially, dorsoventrally flattened, with longitudinal median ridge reaching apex (Fig. 26f); penis valve bridge long, basally pointed (Fig. 26h) . . . . . *Rhinomegilla*

11. Length usually 9-24mm; S6 simple without pad of hair; gradular process of T7 at most obtusely projecting, usually not developed (Figs. 13c, g, 27a); apex and base of disc of S7 wider than middle, apex laterally angulate or with two lobes as in Figures 13e, i, 16g, 20d, 27d, k 12
— Length usually 7.5-13.5mm and/or S6 with thick pad of hair (often hidden until sternum is relaxed and pulled apically); gradular process of T7 often prolonged into tooth (Figs. 30f, g) when body size is small; apodeme of S7 usually short, apex of disc laterally simple, not with two lobes, lateral margins of disc parallel or apically converging, or if narrowed medially then apex of disc laterally simple as in Figures 30e, 30j, 32e, 32i. . . . *Heliophila*
12. Pygidial plate present (Figs. 13c, g), sometimes lateral tooth below pygidial plate also present (Figs. 20h, i, k); gradular process of T7 sometimes present 13
— Pygidial plate and lateral tooth absent, apex of T7 with two submedian teeth (Figs. 27a, f); gradular process of T7 absent 14
13. Basitibial plate present (Fig. 29a) and hind basitarsus simple, nearly parallel-sided; pygidial plate with margin carinate and not concave (Fig. 13c); gradular process of T7 sometimes present (Fig. 13c). . . . *Pyganthophora* (in part)
— Basitibial plate absent or if present, then hind basitarsus with anterior process dilated, not parallel-sided; pygidial plate with margin rounded, almost never carinate (Figs. 20h, i, k-m) if carinate, then lateral margin concave (Fig. 20n); gradular process of T7 absent . . . . . *Paramegilla* (in part)
14. S7 apically broad as in Figures 16g, 27d; S8 with broad, deep apical emargination (weak in *A. calcarata*), lateral margin on apical half concave (Figs. 16h, 27b) 15
— S7 apically narrow as in Figures 19e, 27k; S8 with narrow shallow apical emargination, lateral margin on apical half angulate or concave (Figs. 19c, 27h) 16
15. S8 with apicolateral margin angulate, spiculum projecting somewhat basally (Fig. 27b); S7 with apex shallowly emarginate with two weakly developed apicolateral lobes, apodeme with lateral process (Fig. 27d); apex of gonocoxite somewhat bilobed in profile, lower lobe weakly developed, not with carinae, sometimes with a tooth on lower inner margin of gonocoxite (Fig. 27e); face almost always with yellow markings . . . . . *Petalosternon*
— S8 with apicolateral margin prolonged and rounded, spiculum not easily visible from ventral aspect but projecting dorsally at a 90 degree angle (Fig. 16h); S7 with apex distinctly emarginate with two strong apicolateral lobes, apodeme without lateral process (Fig. 16g); apex of gonocoxite complex in profile with dorsoventral and lateral carinae (Fig. 16k); face with white markings . . . . . *Mystacanthophora*
16. T7 with two short submedian teeth, their bases separated by convex lamellate (Fig. 19d) or angular apical margin; median longitudinal carina often present; actual apical zone of T7 as seen from ventral view, narrow where bent anteroventrad as in Figure 27a; hind basitarsus anteriorly with tooth, blunt process or longitudinal ridge (Figs. 19g, 20g, j, o); apodemes of S7 almost always short (see character j of *Paramegilla*), .34-.78 as long as length of disc, lateral process absent (Figs. 19e, 20d); apex of gonocoxite in profile simple to weakly bilobed (Figs. 19b, 20b). . . . . *Paramegilla* (in part)
— T7 with two long submedian teeth, their bases separated by rounded apical margin; actual apical zone of T7 as seen from ventral view wide where bent ventroanteriad (Fig. 27f); hind basitarsus almost paralled-sided, anteriorly simple; apodemes of S7 long, 1.00-1.75 as long as length of disc, lateral process present (Fig. 27k); apex of gonocoxite in profile deeply bilobed (Figs. 27j). . . . . *Dasymegilla*
17. Flabellum narrowly elongate, apically

entire (Figs. 8a, 25d) or with numerous short, small lobes (Fig. 26b); flagellomere 1 equal in length to next 3.2-4.0 flagellomeres taken together 18

— Flabellum wide, with few long finger-like apical lobes (Fig. 8c); flagellomere 1 equal in length to next 2.2-5.5 flagellomeres taken together 20

18. Malar space long, more than one-third as long as wide (Figs. 25h, 26c); flabellum elongate with apical two-thirds narrowed (Fig. 25d) or flabellum with numerous small apical lobes (Fig. 26b); posterior longitudinal margin of hind tibia with scopal hairs simple as in Figure 10e 19

— Malar space almost always short, rarely well developed, at most one-third as long as wide (Fig. 12e); flabellum more or less parallel sided, not narrowed in apical two-thirds, apex entire (Fig. 12j); posterior longitudinal margin of hind tibia with scopal hairs plumose (Fig. 12d) . . *Anthophora* s. str.

19. Flabellum apically entire, elongate with apical two-thirds narrowed (Fig. 25d) . . . . . *Anthomegilla*

— Flabellum apically with numerous small lobes (Fig. 26b). . . *Rhinomegilla*

20. Mentum near basal third with a well developed anterior tooth (Fig. 22k); flagellomere 1 equal in length to next 2.4-3.3 flagellomeres taken together 21

— Mentum on basal third simple, without anterior tooth [if with tooth then from the Old World and with posterior longitudinal zone of scopa plumose *(A. excisa)*]; flagellomere 1 equal in length

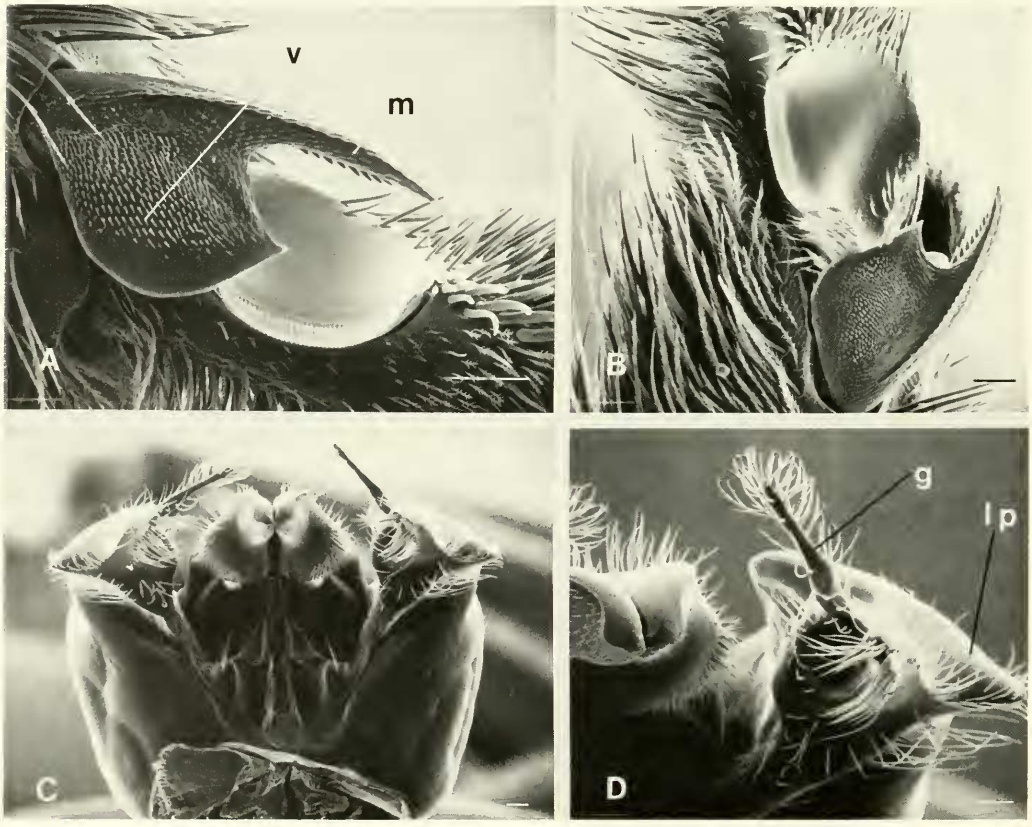


FIG. 11. Antennal cleaner and genital capsule. Scale lines (on right side) represent .1 mm; v = velum, m = malus, g = gonostylus, lp = lateral carinal process. A, B, strigilis of female of *Anthophora (Mystacanthophora) arequipensis* and *Amegilla (Amegilla) quadrifasciata.* C, D, *Anthophora (Mystacanthophora) urbana,* ventral view of genital capsule and apex of gonocoxite.

to next 2.2-5.5 flagellomeres taken together 22

21. Hind basitarsus with posterior distal process acute (Figs. 22h, 23c); S6 with subapical tooth; posterior margin of hind tibia with simple hair (Figs. 10e, 22h); body longer than 13 mm . . . . . *Melea*

— Hind basitarsus with posterior distal process blunt as in Figure 12d; S6 without subapical tooth; posterior margin of hind tibia with plumose hair (Fig. 10a); body no longer than 13 mm . . . . . *Anthophoroides*

22. Posterior margin of hind tibia with simple hair (Figs. 10d, e, 22h); length 6-15 mm. 23

— Posterior margin of hind tibia with plumose hair (Figs. 10a, c, 12d); length 10-24 mm 24

23. Face black, body length 12-14 mm; Mediterranean region . . . . . *Paramegilla* (in part)

— Face almost always with yellow to white integumental markings and body length 6-15 mm; if face black then length from 11-13 mm and southern African in distribution . . . . . *Heliophila*

24. Clypeus almost always black, rarely with pale integumental marking, if markings are present then not in shape of inverted "T" or if in shape of inverted "T", then flagellomere 1 longer than combined lengths of next three flagellomeres 25

— Clypeus with pale integumental marking in shape of inverted "T" (Fig. 18g); flagellomere 1 equal in length to next 2.2-3.0 flagellomeres taken together . . . . . *Caranthophora* (in part)

25. Metasoma with apical bands of hair complete and/or surface covered with semi-erect to erect hair. 26

— Metasoma with apical bands of hair interrupted medially or surface covered evenly with appressed hair (Figs. 21c-e). . . . . *Paramegilla* (in part)

26. Clypeus normal, without apically hooked or wavy hairs or basal pecten; flagellomere 1 equal in length to next 2.2-5.5 flagellomeres taken together . . . . . *Caranthophora* (in part), *Dasymegilla, Lophanthophora, Mystacanthophora* in part), *Paramegilla* (in part), *Petalosternon* and *Pyganthophora*

— Clypeus flattened, with hairs apically hooked or wavy, with a basal pecten (Figs. 17a-e); flagellomere 1 equal in length to next 2.2-3.4 flagellomeres taken together. . . . . *Mystacanthophora* (in part)

Subgenus *Anthophora* Latreille s. str.

Podalirius Latreille, 1802a, p. 430. Name suppressed by ICZN Opinion 151 (Hemming, 1944).

Anthophora Latreille, 1803, p. 167.

Type species: *Apis pilipes* Fabricius, 1775 (=*Apis plumipes* Pallas, 1772, see *Comments*) designated type and *Anthophora* put on Official List of Generic Names by ICZN, Opinion 151 (Hemming, 1944).

Lasius Panzer, 1804, H. 86, T. 16. **New Synonym.**

Type species: *Lasius salviae* Panzer, 1804 (=*Anthophora crinipes* Smith, 1854, p. 324). Monobasic. (See *Nomenclatorial History*).

Megilla Fabricius, [1805], p. 328. See Richards (1935) for comment on the date.

Type species: *Apis pilipes* Fabricius, 1775, designated by Michener, 1984, p. 139.

Diagnosis. Male without pygidial plate, with two submedian teeth on apex of T7 (Fig. 12k); midtarsal, midbasitarsal, middistitarsal brushes of male almost always present (Fig. 12c); S7 on lateral margin of disc with two well developed lobes, a dorsal and a ventral one, apodeme long, never with lateral tooth (Fig. 12n); S8 wide apically, spiculum from ventral aspect short and blunt (Fig. 12i); apex of gonocoxite deeply bilobed (Figs. 12f, g); flabellum apically entire, not lobed (Fig. 12j); basitibial plate of male weakly delimited to absent.

Description. a. Flagellar segment 1 of female equal to length of next 3.25-4.00 segments together; of male to next 2.00-3.75 segments. b. Face of male with yellow markings, of female black (except labrum of *A. melanognatha* has light-yellow spot); mandible of male with pale spot. c. Malar space of female about five times wider than long, of male about six times wider than long; flabellum apically simple, without deeply lobed anterior margin (Fig. 12j); mentum simple without anterior tooth basally, mentum about .6-.7 as long as prementum; paraglossa about .6-.8 as long as stipes. d. Midtarsal brush of male well developed (Fig. 12c) (except absent in *lanata,* weakly developed in *fulvitarsis* and *subterranea*). e. Midbasitarsal brush of male well developed (Fig. 12c) (except absent in *lanata*). f. Middistitarsal brush of male well developed (Fig. 12c) (except weakly developed in *lanata*). g. Hind basitarsus of male simple (Figs. 12a, b). h. Basitibial plate of male poorly defined to absent. i. S6 of male apicomedially emarginate [emargination slight to

absent in *plumipes* (Fig. 12l)], with a lateral depression (Fig. 12l), with a submedian lightly sclerotized area. j. Disc of S7 of male narrowly emarginate apically, with apicolateral angle, lateral margin medially with ventral lobe, basally with dorsal lobe, in profile as in Figure 12m; base of disc with a pair of protuberances, sometimes only represented by darkly sclerotized areas (Fig. 12n); apodeme long, at least 1.33 times as long as disc. k. S8 of male with four small projections apically, submedian pair more darkly sclerotized than lateral pair; longitudinal sclerotization absent (Fig. 12i). l. Apex of gonocoxite of male deeply bifid, inner arm bearing gonostylus (Fig. 12f). m. Gonostylus of male from ventral view long, about 5.75 times longer than wide (Fig. 12f). n. Penis valve apex large, about twice as long as wide viewed apicodorsally. o. Penis valve bridge basally emarginate (sometimes only weakly), of moderate length, 1.5-2.0 times longer than wide. p. Pygidial plate of male absent; T7 with two apical submedian teeth separated by emargination two or more times as wide as deep; gradular process of T7 absent. q. First recurrent vein joining submarginal cell 2 distad of midpoint (occasionally meeting submarginal cell at midpoint). r. Sting in repose slightly exceeding apex of gonostylus, twice as long as gonostylus. s. Body length 10-19 mm.

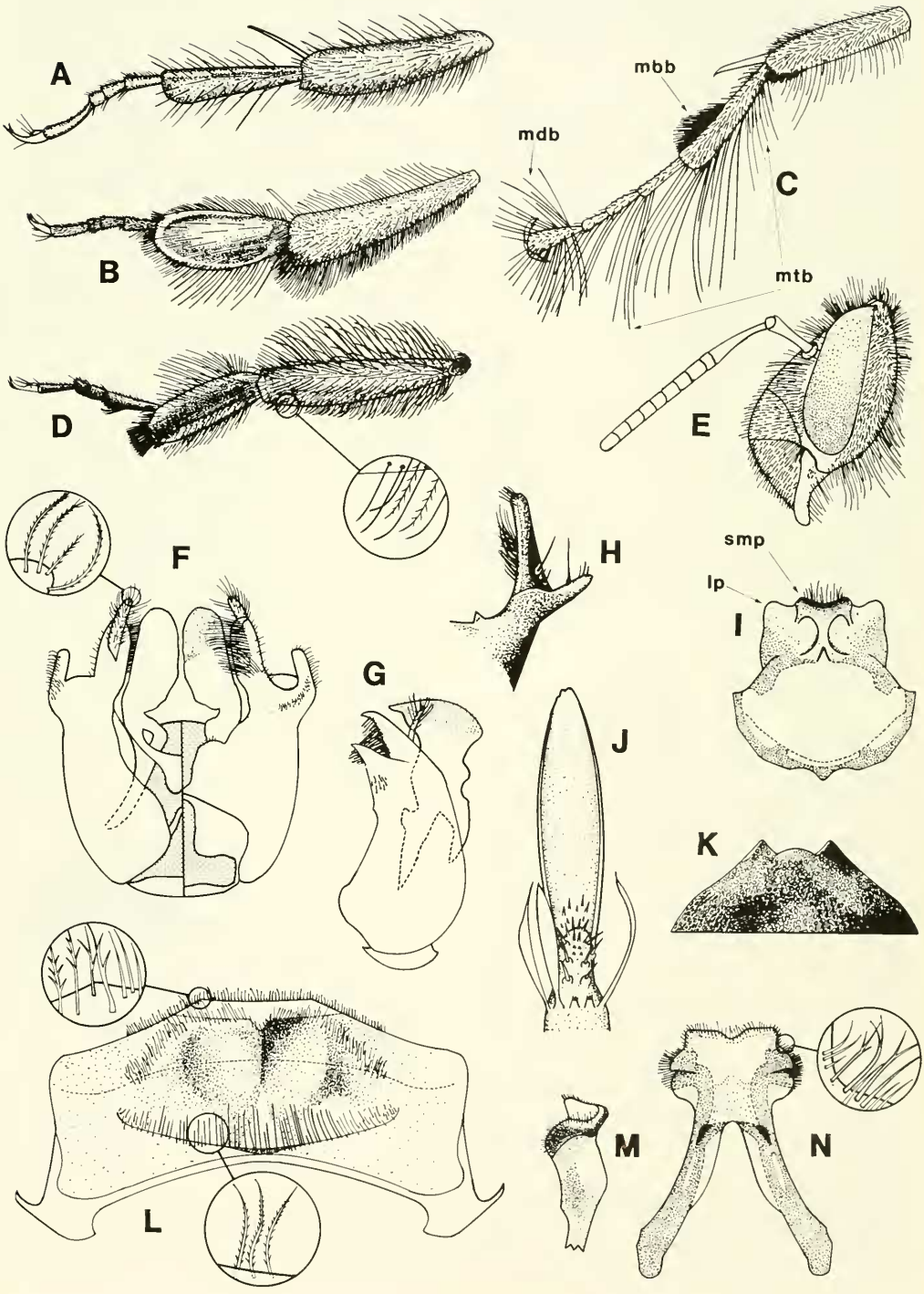
Comments. This subgenus is closely related to *Pyganthophora* from which it can be separated readily in the male by the absence of a pygidial plate, the presence of two well developed lobes on the lateral margin of S7 apically and of a long acute spiculum as seen in ventral aspect; in the female by the shape of the flabellum which is apically entire.

Nomenclatorial History. Day (1979) discussed at length the status of *Apis acervorum* Linnaeus, 1758, long regarded as the type species of *Anthophora.* In reviewing the work of Kirby (1802), Løken (1973) and others noted that he placed *A. acervorum* L. as a species of *Bombus* but was uncertain as to which one. (The type is believed lost.) Dahlbom (1832), Thomson (1872) and Løken (1973) placed *A. acervorum* L. as a synonym of *Apis subterranea* L., which is a species of *Bombus.* Linnaeus (1746, 1758) indicated that *Apis acervorum* was similar to *A. subterranea* L. and *A. terrestris* L. and later (1761) to *A. lucorum* L., all species of *Bombus.* Kirby (1802) suspected that *A. acervorum* L. was a male of *A. harrisella* Kirby, which is a melanic *Bombus hortorum* (Løken, 1973 and pers. comm.). In the Scandinavian populations of *Bombus subterraneus* queens and workers may have a somewhat yellow collar and slightly melanic males may occur (Løken, 1973 and pers. comm.) and would fit the Linnaean description of *A. acervorum* reasonably well. Fabricius (1775) was the first to mistakenly apply the name *acervorum* L. to a species now placed in *Anthophora.* As Kirby (1802) pointed out and Illiger (1806) reiterated, Fabricius used the name *acervorum* for *Apis plumipes.* He subsequently added to the Linnaean description "tibiis posterioribus ferrugineis," which Gmelin (1790) later incorporated in the 13th edition of Systema Naturae. Considering the arguments of Day (1979), Løken's familiarity with the color variation of Scandinavian *Bombus* spp., and the Linnaean diagnosis of *Apis acervorum,* it seems reasonable to agree that *A. acervorum* is a synonym of a species of *Bombus* and probably *subterraneus.* The next available name for *A. acervorum* of Fabricius and most subsequent authors is *Apis plumipes* Pallas, 1772 (=*Apis pilipes* Fabricius, 1775).

The first designation of the type species of *Megilla* Fabricius [1805] was *M. labiata* Fabricius [1805], by Westwood (1840). Since *M. labiata* F. is also the type species of *Macropis* Klug, 1809, a well known genus of melittids, Michener (1983) proposed the suppression of the Westwood type designation, as did Benson, Ferrière & Richards (1937). This proposal would in effect validate the second type species designation for *Megilla* by Richards (1935) i.e., *A. acervorum* L. But Richards unwittingly misidentified *A. acervorum* L., following most authors since Fabricius, having the Fabrician *acervorum* (=*A. plumipes*) in mind, not knowing the probable identity of *Apis acervorum* Linneaus. Since *A. acervorum* of Linneaus is a synonym of *B. subterraneus,* which is the type of *Subterraneobombus* Vogt, 1911, *Megilla* would have priority over that subgenus of *Bombus.* The least disruptive measure would be to designate *Apis pilipes* Fabricius, 1775, to replace *A. acervorum* L. as type of *Megilla,* following Michener (1984); thereby, *Megilla* would become a junior synonym of *Anthophora.* Following this course, the ICZN designated *Apis pilipes* Fabricius, 1775, as the type species of *Megilla* Fabricius [1805] (Tubbs, 1986).

Lasius Panzer 1804, not to be confused with *Lasius* Jurine [1801-1802] ("Erlangen List", suppressed by ICZN, Opinion 135) or *Lasius* Fabricius [1805] (a genus of ants), has as its type species *Lasius salviae* Panzer, 1804, by monotypy. Since *Lasius* Fabricius was placed on the Official List of Generic Names, *Lasius* Panzer is a homonym of the former and a synonym under *Anthophora.* When *Lasius salviae* Panzer is reassigned to

FIG. 12. *Anthophora* subgenus *Anthophora.* A, H, *A. (A.) melanognatha,* male; B-G, I-N, *A. (A.) plumipes;* lp = lateral process of apex of S8, mbb = midbasitarsal brush, mdb = middistitarsal brush, mtb = midtarsal brush, smp = submedian process of apex of S8. A, Hind leg (outer view). B, C, Hind and midleg of male (outer view). D, E, Hind leg, outer view and head, side view of female. F, G, Genital capsule, dorsoventral and side views. J, Flabellum, anterior view. K, Apex of T7 of male (hair omitted), dorsal view. L, S6 of male, ventral view. M, N, S7, disc, side view and S7, ventral view.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the genus *Anthophora* there is no problem of homonymy with *Anthophora salviae* Morawitz, 1876, since the latter is a species of the genus *Amegilla*. Article 59c of the ICZN states that as long as the two taxa in question are not congeneric, the junior homonym does not require a new replacement name.

Plumipes Species Group

g. Hind basitarsus of male flattened and wide (Fig. 12b) (*A. salviae* narrow), not angulate anteriorly. h. Basitibial plate of male absent. i. S6 of male without protuberances (Fig. 12l). j. S7 of male with apodeme about twice as long as length of disc (Fig. 12n). l. Arms of male gonocoxite curved and irregularly shaped (Fig. 12f). m. Gonostylus of male moderate in width, 5.7-6.0 times longer than wide (Fig. 12f). o. Penis valve bridge about twice as long as wide. p. T7 of male with submedian apical teeth about .1 as long as distance between their outer bases (Fig. 12k).

Biology. Almost all of the known biology of *Anthophora* s. str. is based on studies of *A. plumipes* (as *acervorum*) by Malyshev (1928), Nielsen (1902), Torikata (1931, as *villosula*), Van Lith (1947), and Verhoeff (1892a, b). Radović and Krunić (1977) reported on the biology of *salviae* (as *A. crinipes*). Polychromatism is found in *Anthophora* s. str. as well as in other subgenera.

Included Species. A. (Anthophora) chinensis Friese, *lanata* (Klug), *patruelis* Cockerell, *plumipes* (Pallas), *salviae* (Panzer), *senescens* Lepeletier, and *uljanini* Fedtschenko. They occur from Europe to Korea and eastern China.

Melanognatha Species Group

g. Hind basitarsus of male longitudinally angulate and narrow (Fig. 12a). h. Basitibial plate of male present but poorly defined (absent in *A. fulvitarsis*). i. S6 of male with two lateral protuberances and a subapical median protuberance. j. S7 with apodeme about 1.33 times as long as length of disc. l. Arms of male gonocoxite straight and gradually tapering apically (Fig. 12h). m. Gonostylus of male narrow, about 9 times as long as wide. o. Penis valve bridge about 1.5 times as long as wide. p. T7 of male with apical teeth about .4 as long as distance between their outer bases.

Biology. The biology of *A. aegyptiaca* (Ibrahim, 1976; Mohamed, 1975) and *fulvitarsis* (sometimes reported as *personata*) (Escalera, 1910; Nielsen, 1902; Semichon, 1906; Verhoeff, 1892a) has been studied.

Included Species. A. (Anthophora) aegyptiaca Dalla Torre & Friese, *fulvitarsis* Brullé, *melanognatha* Cockerell, and *subterranea* Germar. All are largely Mediterranean species.

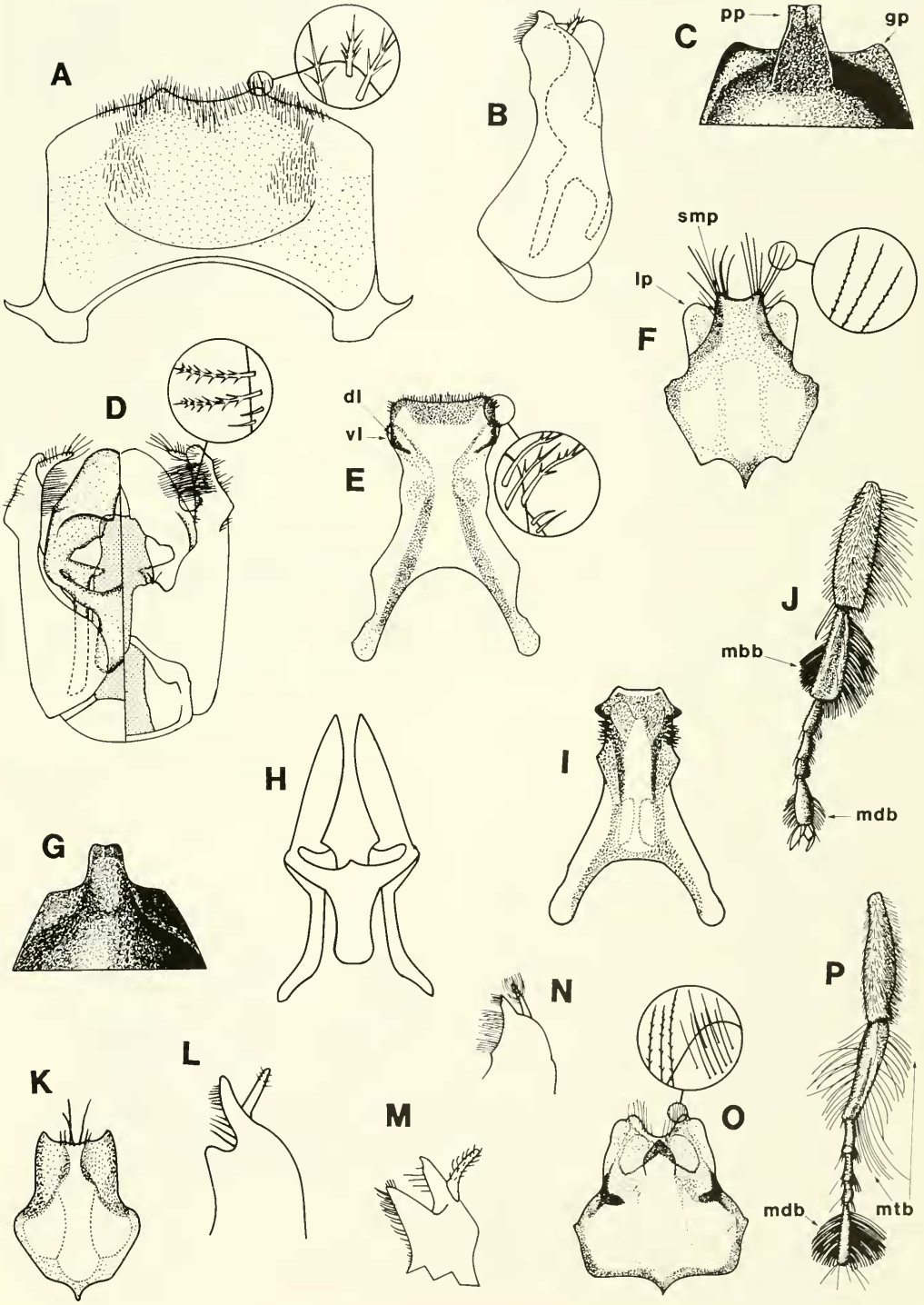
Pyganthophora new subgenus

Type Species: *Apis retusa* Linnaeus, 1758.

Diagnosis: Male with a well developed pygidial plate (Figs. 13c, g); midtarsal, midbasitarsal, and middistitarsal brushes of male present or absent; S7 of male with two weakly developed lobes, a dorsal and a ventral one, both on lateral margin of apical half, apodeme often with a lateral tooth (Figs. 2a, 13e, 13i); S8 of male apically wide, spiculum in ventral aspect long and acute (Figs. 2b, 13f, 13k), apex of gonocoxite of male weakly to strongly bifid, rarely simple.

Description: a. Flagellar segment 1 of female equal to length of the next 3.75-5.50 segments together; of male to next 2.67-4.20 segments. b. Face of male with yellow (except all black in *A. angolensis, belieri, erschowi, nigriceps, nigrifacies, rogenhoferi,* and *sichelii;* with white in *albosignata, leucorhina, scopipes,* and *spinolana*); face of female black; mandible of male black (except *crotchii, forbesi,* and *platti* with yellow spot basally, *altaica* and *leucorhina* with white). c. Malar space of female 3.0-6.0 times as wide as long, of male 3.3-9.0 times as wide as long; flabellum with several long finger-like lobes at apex; mentum simple, without anterior tooth basally, mentum .6-.7 as long as prementum; paraglossa .6-.9 as long as stipes. d. Midtarsal brush of male absent [except in the western U.S. *crotchii, lesquerellae,* and *vannigera* (Fig. 13p)]. e. Midbasitarsal brush of male absent to present [well developed in *alluaudi, angolensis, atroalba, balearica, belieri, erschowi, holoxantha, retusa,* and *sichelii* (Fig. 13j)]. f. Middistitarsal brush of male absent to well developed (Figs. 13j, p). g. Hind basitarsus of male simple, without tooth (except in *edwardsii*), flattened, 2.8-4.1 times as long as wide. h. Basitibial plate of male well defined (Fig. 29a). i. S6 of male apicomedially emarginate, lateral depression and a central lightly sclerotized area sometimes present on disc (Fig. 13a). j. Disc of S7 of male (Figs. 13e, i) broadly and shallowly emargi-

FIG. 13. *Anthophora* subgenus *Pyganthophora,* males. dl = dorsal lobe of apicolateral margin of S7, gp = gradular process of T7, lp = lateral process of S8, mbb = midbasitarsal brush, mdb = middistitarsal brush, mtb = midtarsal brush, pp = pygidial plate, smp = submedian process of S8, vl = ventral lobe of apicolateral margin of S7. Hair is omitted from the apex of T7 (C, G). A-F, J, *A. (P.) retusa;* G, N-P, *A. (P.) crotchii;* H, I, K, L, *A. (P.) rogenhoferi;* M, *A. (P.) edwardsii.* A, S6, ventral view. B, Genital capsule, side view. C, Apex of T7, dorsal view. D, Genital capsule, dorsoventral view. E, F, S7 and S8, ventral views. G, Apex of T7, dorsal view. H, Penis valves, dorsal view. I, S7, ventral view. J, Midleg, outer view. K, S8, ventral view. L-N, Apex of gonocoxite, side view. O, S8, ventral view. P, Midleg, outer view.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nate apically, with apicolateral angle, lateral margin apically with a dorsal and ventral lobe as in Figure 13e; base of disc with dark sclerotized areas sometimes present (Fig. 13i); apodeme short to long, 0.5-1.0 times as long as length of disc. k. S8 of male (Figs. 13f, k, o) with 2 or 4 apical projections; longitudinal sclerotization present. l. Apex of gonocoxite of male weakly to strongly bifid (Figs. 13l-n). m. Gonostylus of male short to moderate in length, 5.0-8.5 times as long as wide (Figs. 13l-n) (13.5 times as long as wide in *platti*), narrow and sometimes flattened. n. Penis valve apex small and narrow to large and thick, 1.0-4.5 times longer than wide viewed apicodorsally. o. Penis valve bridge basally emarginate (Fig. 13d) [except in Rogenhoferi species group (Fig. 13h)], 1.3-3.0 times longer than wide. p. Pygidial plate of male present, well defined, apically entire to weakly emarginate (strongly emarginate in *orientalis*) without teeth (Figs. 13c, g); lateral margins carinate, rarely only angulate; gradular process of T7 of male absent to present. q. First recurrent vein joining submarginal cell 2 distad of midpoint. r. Sting in repose attaining or surpassing apex of gonostylus, 2.0-2.5 times as long as gonostylus. s. Body length 12-16 mm.

Comments and Biology. Pyganthophora flies from February to June. The Nearctic species are referred to as the Edwardsii group by Brooks (1983), but are here placed in two groups, one of which is Holarctic and Ethiopian. *Pyganthophora* is closely related to *Anthophora* s. str. but can be separated from it by the apically lobed flabellum, the presence of a pygidial plate in the male and the characters of the male S7, S8 and genital capsule given in the diagnosis.

Etymology. Pygos (Gr.), rump, a prefix referring to the well defined pygidial plate of the males, plus *Anthophora.*

Retusa Species Group

d. Midtarsal brush of male absent (Fig. 13j). e. Midbasitarsal brush of male present (except *A. altaica, arabica, edwardsii, forbesi, subterranea, senilis,* and *testaceipes*). f. Middistitarsal brush of male weakly to moderately developed (Fig. 13j), (absent in *arabica, edwardsii, erschowi, senilis,* and *testaceipes*). j. Disc of S7 of male basally without dark sclerotized areas (except the western U.S. species, *edwardsii* and *forbesi*); apodeme 0.7-1.0 times as long as length of disc (Fig. 13e). k. Apex of S8 of male (Fig. 13f) narrowly emarginate with four apical projections, submedian pair more darkly sclerotized and more acute than lateral pair (seen only in cleared preparation). l. Apex of gonocoxite of male strongly bifid (Figs. 13l, m) [weakly bifid in *alluaudi, angolensis, belieri, erschowi, holoxantha, retusa,* and *testaceipes* (Figs. 13b, n)]. n. Penis valve apex large and thick, 1.0-2.0 times longer than wide viewed apicodorsally. o. Penis valve bridge short and narrow (wide in *platti*), 1.3-2.0 times long as wide, basally emarginate. p. Gradular process of T7 of male present, well defined (absent in Nearctic species).

Biology. The biology of two Old World species has been studied - *retusa* (sometimes under the names *aestivalis* or *monacha*) (Nielsen, 1902; Popova, 1984) and *atroalba* (as *antiope,* Batra, 1980). Only a single New World species of *Pyganthophora, edwardsii,* has been investigated biologically (Thorp, 1969).

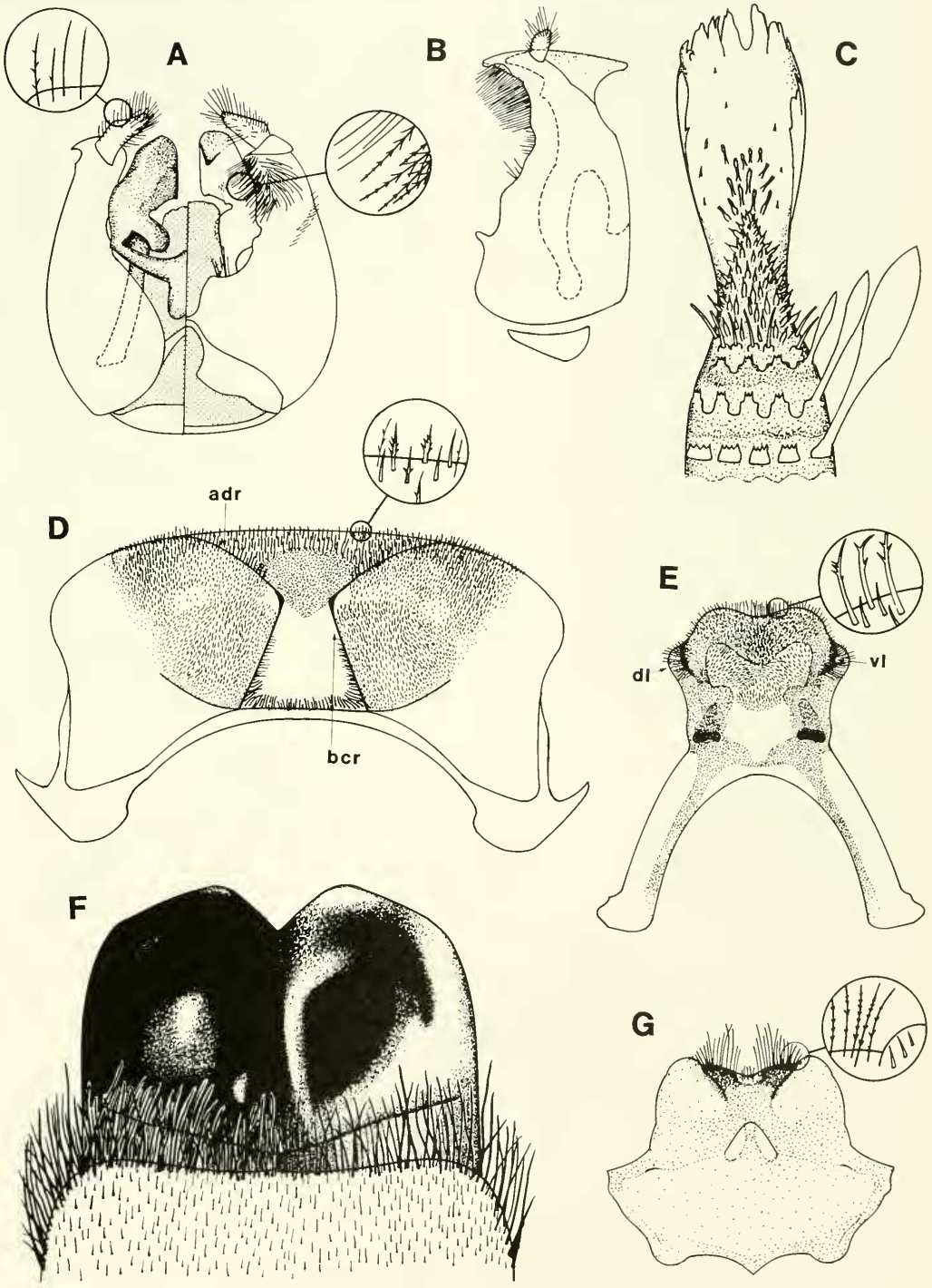
Included Species. A. (Pyganthophora) adamsorum n. sp., *albobarbata* Hedicke, *alluaudi* Pérez, *altaica* Radoszkowsky, *angolensis* (Dalla Torre) new combination, *arabica* Priesner, *atroalba* Lepeletier, *balearica* Friese, *belieri* Dours, *clessini* Fedtschenko, *dalmatica* Pérez, *diversipes* Friese, *edwardsii* Cresson, *erschowi* Fedtschenko, *eversmannii* (Dalla Torre & Friese), *festae* Gribodo, *flabellata* Priesner, *forbesi* Cockerell, *holoxantha* Pérez, *libyphaenica* Gribodo, *nigrifacies* Friese, *nigrilabris* Spinola, *pedata* Eversmann, *platti* Timberlake, *retusa* (Linnaeus), *romandii* Lepeletier, *ruficaudis* (Cameron), *schultzei* Friese, *scopipes* Spinola, *senicula* Pérez, *senilis* Eversmann, *spinolana* Priesner, *strauchi* Fedtschenko, *suworzevi* Morawitz, *testaceipes* Morawitz, and *vernalis* Morawitz. This assemblage includes species from the Holarctic region as well as the South African *A. diversipes, ruficaudis,* and *schultzei.* The nearctic species *edwardsii, forbesi* and *platti* are restricted to the western U.S.

Crotchii Species Group

d. Midtarsal brush of male present. e. Midbasitarsal brush of male absent. f. Middistitarsal brush of male well developed (Fig. 13p). j. Disc of S7 of male basally with lightly to darkly sclerotized areas; apodeme about as long as length of disc (Fig. 2a). k. Apex of S8 of male broadly emarginate with four (sometimes two) weakly developed apical projections, submedian projections usually more developed than lateral projections, lateral projections sometimes absent (Fig. 2b, 13o). l. Apex of gonocoxite of male weakly bifid (Fig. 13n) to simple. n. Penis valve apex large and thick, 1.0-1.3 times longer than wide viewed apicodorsally. o. Penis valve bridge long and narrow, 2.0-2.3 times longer than wide, basally emarginate. p. Gradular process of T7 of male well defined.

Included Species. A. (Pyganthophora) crotchii Cresson, *lesquerellae* (Cockerell), and *vannigera*

FIG. 14. *Anthophora* subgenus *Lophanthophora,* males. A-E, G, *A. (L.) porterae;* F, *A. (L.) dispar.* adr = anterior diverging ridge, bcr = basal converging ridge, dl = dorsal lobe of lateral margin, vl = ventral lobe of lateral margin. A, B, Genital capsule, dorsoventral and side views. C, Flabellum, anterior view. D, E, S6 and S7, ventral views. F, S6 and apex of S5 (hair omitted on S6 but included on S5), ventral view. G, S8, ventral view.


A
B
C
D
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G

Timberlake. The species occur in the Pacific Coast states of the U. S. including Nevada and Arizona.

Rogenhoferi Species Group

d. Midtarsal brush of male absent. e. Midbasitarsal brush of male absent (weakly developed in *A. albosignata*). f. Middistitarsal brush of male present (absent in *leucorhina, rogenhoferi,* and *sichelii*). j. Disc of T7 of male with dark sclerotized areas; apodeme one half the length of disc (Fig. 13i). k. Apex of S8 of male narrowly emarginate with two submedian projections and laterally with a well developed lobe (Fig. 13k). l. Apex of gonocoxite of male moderately to strongly bifid in profile (Fig. 13l). n. Penis valve apex small and narrow, 3.0-4.5 times as long as wide as viewed apicodorsally. o. Penis valve bridge long and narrow about 3 times as long as wide, basally entire (Fig. 13h). p. Gradular process of T7 of male weakly defined.

Comments. Males of *A. albosignata, finitima, ghigii* and *leucorhina* have well developed paraocular marks. Males of *connexiformis, sergia* and *sichelii* have small paraocular marks. All of other males in this group lack paraocular marks which is unusual for *Anthophora* s. l.

Included Species. A. (Pyganthophora) albicilla Pérez, *albosignata* Friese, *andalusica* Pérez, *arida* Brooks, *caroli* Pérez, *cincreus* Friese new combination, *connexiformis* Cockerell, *fascialoides* Brooks, *finitima* Morawitz, *ghigii* Gribodo, *leucophaea* Pérez, *leucorhina* Cockerell, *limassolica* Mavromoustakis, *nigriceps* Morawitz, *nigrifacies* Friese, *orientalis* Morawitz, *pruinosa* Smith, *punctilabris* Pérez, *rogenhoferi* Morawitz, *rubricus* Dours, *sergia* (Nurse), *sichelii* Radoszkowsky, and *ventilabris* Lepeletier. All species of the Rogenhoferi group are Mediterranean and western Asian in distribution.

Lophanthophora new subgenus

Type species: *Anthophora porterae* Cockerell, 1900.

Diagnosis. Distal half of S6 of male with a pair of oblique diverging ridges, basal half with a pair of ridges converging apically (Fig. 14d); apex of gonocoxite of male simple, flattened, hooked ventrad (Figs. 14a, b); pygidial plate and gradular processes present in male (Fig. 15c); male with midtarsal brush sometimes present, midbasitarsal brush usually absent, middistitarsal brush present (Figs. 15a, b, d).

Description. a. Flagellar segment 1 of female equal to length of next 3.8-5.0 segments together (Fig. 7a) (except *A. robusta,* equal to next 3.0 segments), of male to next 3.0-4.2 segments (except *robusta,* equal to next 2.1 segments). b. Face of male with yellow markings (except white in *dammersi* and *neglecta* and all black in *caelebs*), of female black (except *atricilla* with pale markings); mandible of male black (except *agama, turcomanica,* with pale maculae). c. Malar space of female about 3-8 times as wide as long, of male about 3.0-8.5 times as wide as long; flabellum apically with finger-like projections as in Figure 8c (except *caelebs* apically entire); mentum simple basally, without anterior tooth; mentum about .7-.8 as long as prementum; paraglossa about .8-.9 as long as stipes. d. Midtarsal brush of male when present weakly to well developed (Figs. 15a, b, d) (absent in *affinis, agama, amseli, atricilla, biciliata, robusta,* and *turcomanica*). e. Midbasitarsal brush of male usually absent (Fig. 15b) [present in *atricilla, dispar, hispanica,* and *rutilans* (Figs. 15a, d)]. f. Middistitarsal brush of male present (weakly in *caelebs* (Figs. 15a, b, d). g. Hind basitarsus of male simple, without tooth (greatly flattened in *disparilis,* with anterobasal tooth). h. Basitibial plate of male well defined as in Figure 29. i. S6 of male usually entire, sometimes emarginate, distal half with an oblique ridge on each side diverging apically, basal half with same ridges converging apically (basal ridges absent in *disparilis*); disc usually with lateral depression (Fig. 14d). j. Disc of S7 of male broadly emarginate apically (*disparilis* apically produced, rounded), apicolaterally rounded; lateral margin midway with inner ventral lobe and outer dorsal lobe (only dorsal lobe in *disparilis*), in profile as in Figure 14e; base of disc with a pair of protuberances, sometimes represented only by dark sclerotized areas; apodeme at least 1.25 times as long as length of disc. k. S8 of male apically with 2 submedian projections, sometimes a projection on each side of submedian pair; longitudinal sclerotization absent (Fig. 14g). l. Apex of gonocoxite of male simple (weakly bilobed apically in *amseli*), flattened, hooked ventrad (Figs. 14a, b). m. Gonostylus from ventral view 3.0-6.8 times as long as wide (long and narrow in *atricilla,* and *turcomanica,* 20.0 times as long as wide). n. Penis valve apex of moderate length, about 1.0-2.4 times as long as wide viewed apicodorsally. o. Penis valve bridge basally emarginate to entire, 1.6-2.0 times as long as wide (except *disparilis* 1.0, and *rutilans* 2.3-2.6). p. Pygidial plate of male present apically as a median truncate projection, basally expanded and rounded laterally, not carinate, apically emarginate (Fig. 15c); gradular process of T7 of male, well developed. q. First recurrent vein joining submarginal cell 2 near midpoint. r. Sting in repose attaining or slightly surpassing apex of gonostylus, twice as long as gonostylus (occasionally three times). s. Body length 11-20 mm.

Comments and Biology. The species fly from January to July. This subgenus is most closely related to *Pyganthophora* and *Anthophora* s. str. from which it can be separated in the males by the oblique ridges on the distal half of S6, S8 is wider than long (Fig. 14c) without or with weakly developed, lateral and submedian projections on the apex and the shape of the gonocoxite is as stated in the *Diagnosis.* This subgenus is equivalent to the Porterae group of Brooks (1983) in North America.

Etymology. Lophos (Gr.), ridge or crest, indicating the apically diverging ridges on the distal half of S6 of the male, plus *Anthophora.*

Dispar Species Group

b. Labrum of male apically with three projections, median projection emarginate, suggesting that of many *Heliophila* males (Fig. 30l). e. Midbasitarsal brush of male well developed (Fig. 15a), occupying one-third to one-half length of basitarsus. f. Middistitarsal brush of male well developed (Fig. 15a). g. Hind basitarsus of male somewhat round in cross section and dilated. i. S6 of male apically emarginate medially with a large, deep depression on each side of disc (Fig. 14f); S6 of female normal without median subapical projection. j. Disc of S7 of male basally with pair of tooth-like protuberances. k. S8 of male strongly angulate apicolaterally. m. Gonostylus of male round in cross section, about 3.5 times as long as wide. n. Apex of penis valve about 1.6 times as long as wide viewed apicodorsally. o. Penis valve bridge basally emarginate, 1.7 times as long as wide. p. Pygidial plate of male not distinct, represented as a median shelf-like projection, apically wide, about .4 times the distance between the apices of gradular processes. q. First recurrent vein joining submarginal cell 2 distad of midpoint. r. Sting in repose attaining apex of gonostylus, about twice as long as gonostylus.

Included Species and Biology. Included here is only one Mediterranean species, *A. (Lophanthophora) dispar* Lepeletier, the biology of which in Egypt was described by Ibrahim (1976, as *A. speciosa* Friese).

Porterae Species Group

b. Labrum of male medioapically with a weakly emarginate projection, apical margin sometimes flexed outwardly, greatly produced. e. Midbasitarsal brush of male absent (weakly present in *A. atricilla*), though *ursina* and *dammersi* have an apparently different, derived, dense group of flattened, orange hairs in the same position as a basitarsal brush. f. Middistitarsal brush of male weakly to well developed. g. Hind basitarsus of male flattened. i. S6 of male apically entire (sometimes emarginate as in *affinis, agama, biciliata, disparilis, neglecta, robusta, turcomanica,* and *ursina*), with a shallow depression on each side (Fig. 14d) (depression absent in *disparilis*); S6 of female normal, without median subapical projection. j. Disc of S7 of male with a basal pair of dark sclerotized areas and/or tooth-like protuberances (Fig. 14e). k. S8 of male apicolaterally rounded (Fig. 14g). m. Gonostylus of male flattened to round in cross section, short to long, 2.5-8.5 times as long as wide (Figs. 14a, b) (long in *atricilla,* and *turcomanica,* 20 times longer than wide). n. Penis valve apex about as long as wide as viewed apicodorsally. o. Penis valve bridge basally emarginate, 1.6-2.3 times as long as wide, short in *disparilis,* 1.0). p. Pygidial plate of male distinct, apically wide, about 0.3 the distance between apices of gradular processes (Fig. 15c). q. First recurrent vein joining submarginal cell 2 basal to or distal to midpoint. r. Sting in repose attaining or slightly surpassing apex of gonostylus, 2-3 times as long as gonostylus.

Comments. A. disparilis Friese is a strange species in that the male has an all black labrum, greatly flattened hind basitarsus with a tooth and

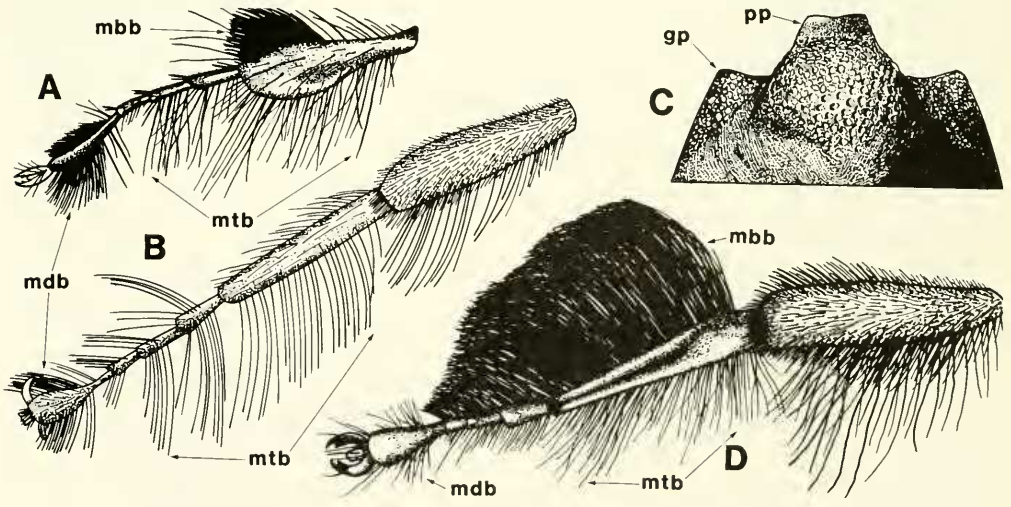


FIG. 15. *Anthophora* subgenus *Lophanthophora,* males. gp = gradular process, mbb = midbasitarsal brush, mdb = middistitarsal brush, mtb = midtarsal brush, pp = pygidial plate. A, Midleg of *A. (L.) dispar,* outer view. B, C, *A. (L.) porterae,* midleg, outer view and apex of T7 (hair is omitted), dorsal view. D, *A. (L.) hispanica,* midleg, outer view.

nontypical S7 and S8 and genital capsule.

Biology. North American species of *Lophanthophora* are active from spring to early summer, that is, from mid January to July (there have been two U. S. specimens collected in August and flight records in Texas as early as November). The palearctic species fly from February to May. All *Lophanthophora* whose habits are known are polylectic, and at least *A. pacifica* overwinters as an adult in Utah (P. Torchio, pers. comm.). In the Old World only the biology of *affinis* (as *radoszkowskyi*) is known (Radchenko, 1984).

Included Species. A. (Lophanthophora) affabilis Cresson, *affinis* Brullé, *aflabellata* Gribodo, *agama* Radoszkowsky, *amseli* Hedicke, *atricilla* Eversmann, *biciliata* Lepeletier, *bifasciata* Fedtschenko, *bogdanowi* Fedtschenko, *caelebs* Gribodo, *clessini* Fedtschenko, *cinerascens* Lepeletier, *coptognatha* Timberlake, *dammersi* Timberlake, *disparilis* Friese, *fedorica* Cockerell, *fratercula* Gribodo, *fuliginosa* Morawitz, *heinemanni* Fedtschenko, *kochi* Fedtschenko, *melanocephala* Fedtschenko, *murutica* Friese, *neglecta* Timberlake & Cockerell, *niveiventris* Friese, *pacifica* Cresson, *porterae* Cockerell, *pretiosa* Friese, *robusta* (Klug), *turcomanica* Morawitz, and *ursina* Cresson. *Lophanthophora* is holarctic and found generally throughout the United States, Europe, north Africa to central Asia.

Hispanica Species Group

b. Labrum of male apically entire or weakly emarginate, median projection present. e. Midbasitarsal brush of male well developed (Fig. 15d), occupying three-fourths length of basitarsus. f. Middistitarsal brush of male weakly developed (Fig. 15d). g. Hind basitarsus of male flattened. i. S6 of male apicomedially entire to weakly emarginate, disc flat without lateral depression; S6 of female with median subapical projection in *A. hispanica.* j. Disc of S7 of male laterobasally with only dark sclerotized area, no tooth. k. S8 of male apicolaterally rounded. m. Gonostylus of male flattened, short, 3.1-4.3 times as long as wide. n. Apex of penis valve as long as wide viewed apicodorsally. o. Bridge of penis valve basally emarginate to entire, 1.6-2.6 times as long as wide. p. Pygidial plate of male distinct, apically wide, about .2 of distance between apices of gradular processes. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose slightly surpassing apex of gonostylus, twice as long as gonostylus.

Biology. The members of this group fly from March to April.

Included Species. A. (Lophanthophora) hispanica (Fabricius) and *rutilans* Dours. Both are Mediterranean in distribution.

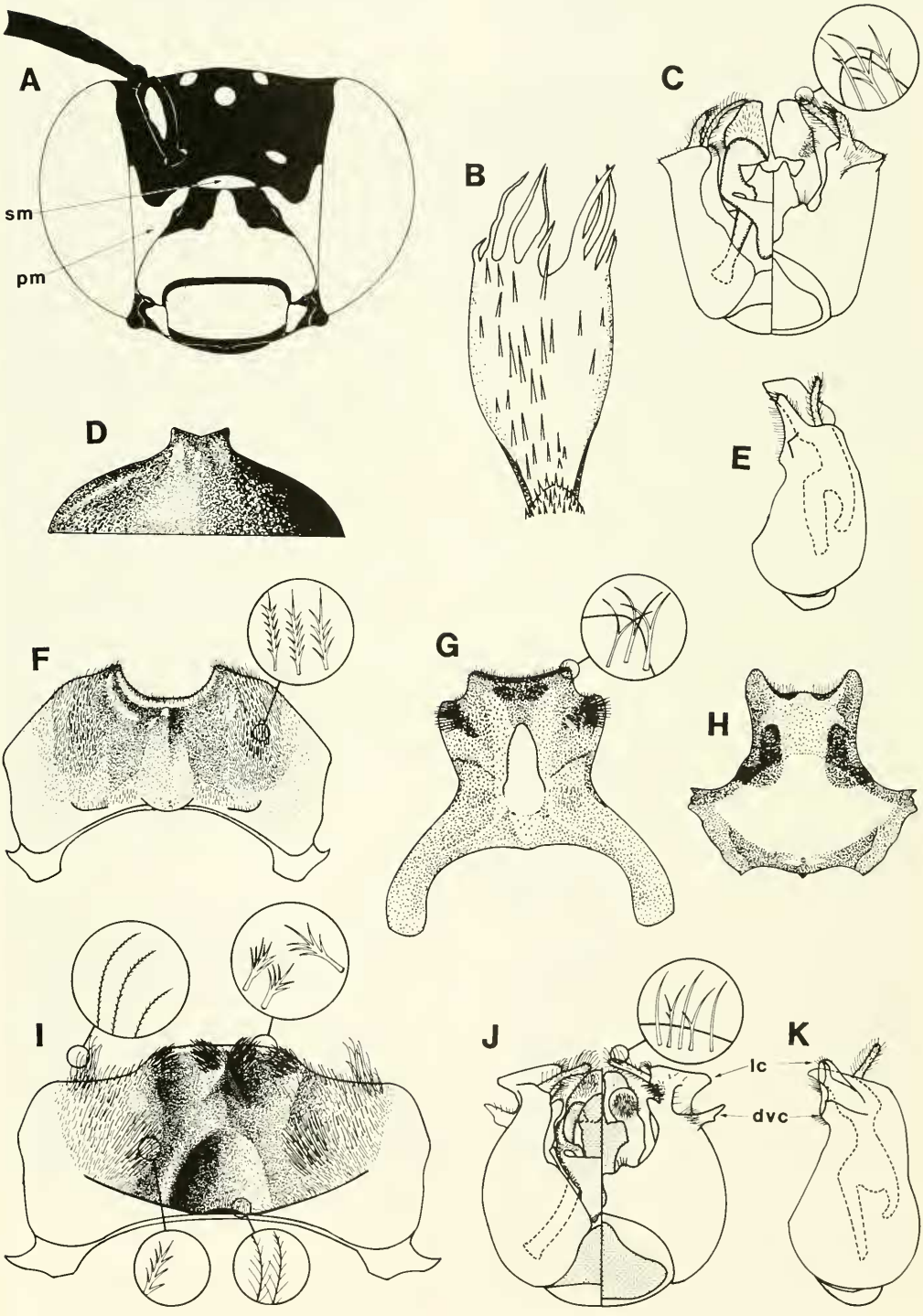
***Mystacanthophora* new subgenus**

Type Species: *Anthophora montana* Cresson, 1869.

Diagnosis. Female with flat or weakly convex face, clypeus in profile at most .8 width of eye; clypeus usually with erect apically hooked or wavy hairs and often basally with a pecten (Figs. 17a-e); male almost always with S5 and S6 greatly modified (see character j and Figs. 16f, i, 17f); apex of S7 of male with two well developed lateral lobes, disc broad and wide, center with an oval clear area (Fig. 16g); S8 of male broadly and deeply emarginate with well developed lateral lobe, base laterally with short tooth (Fig. 16h); apex of gonocoxite of male complex with a lateral and dorsoventral carina (Figs. 16j, k), only dorsoventral carina present in western U. S. species *A. urbana* (Figs. 16c, e); face of male white to creamy white.

Description. a. Flagellar segment 1 of female equal to length of next 2.2-3.0 segments together (*A. paranensis,* 3.4), of male 1.0-2.0 segments. b. Face of male with white markings, occasionally cream-colored; mandible with white spot basally (except the Antillean *tricolor* and *footei* with no basal spot), pale marking on clypeus distinctive with apicolateral black area (Fig. 16a) (except that *boharti, urbana,* and the Antillean *Anthophora* have clypeus completely white except for black spots on anterior tentorial pits); face of female black [except *bahamensis* with white on clypeus (Fig. 40i)]; clypeus often basally with a pecten and usually covered with short, apically hooked or wavy hairs (Figs. 17a-e) (hooked hairs and/or pecten absent on *bahamensis, boharti, borealis, arequipensis, footei, tricolor,* and *urbana*). c. Malar space of female 5-16 times as wide as long, of male 5-10 times as wide as long; flabellum with several apical finger-like lobes (Fig. 16b); mentum simple, without anterior tooth on basal third, mentum .25-.37 as long as prementum; paraglossa .68-.76 as long as stipes. d-e. Midtarsal and midbasitarsal brushes of male absent. f. Middistitarsal brush of male absent (present weakly in *walshii* and *borealis*). g. Hind basitarsus of male simple, without teeth, about three times as long as wide. h. Basitibial plate of male almost always poorly defined to absent (well defined in *capistrata* and *walshii*). i. S6 of male usually broadly emarginate apicomedially, with a lateral depression (Fig. 16f), South American species have apical margin entire or with median, shallow emargination (i.e., *paranensis*), or with median third of apical margin produced, truncate (i.e., *arequipensis*); S5 of male modified with four apical tufts of black hair (Figs. 17f, 41g) or black hair tufts coalesced, forming a thick apical band

FIG. 16. *Anthophora* subgenus *Mystacanthophora,* males. A, B, D, F-K, *A. (M.) montana;* C, E, *A. (M.) urbana.* Hair omitted in A, D. dvc = dorsoventral carinal process, lc = lateral carinal process, pm = paraocular mark, sm = supraclypeal mark. A, Face. B, Flabellum, anterior view. C, E, Genital capsule, dorsoventral and side views. D, Apex of T7, dorsal view. F, S6, ventral view. G, S7, ventral view. H, S8, ventral view. I, S5, ventral view. J, K, Genital capsule dorsoventral and side views.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(Fig. 16i); median third of apical margin broadly produced, truncate (Fig. 16i) [except in *urbana* normal, apical margin entire; *borealis* without black hair, apical margin entire, with a dense transverse band of white hair on basal third; and *boharti* with apical band of brown hair (Fig. 41f)]. j. Disc of S7 of male (Fig. 16g) with apex broadly emarginate [that of *boharti* broadly produced, with apicolateral margin angulate, lateral margin at apical three-fourths with large lobe (Fig. 40c)], basally disc without protuberances or dark sclerotized areas; apodeme short, 0.5-1.0 as long as length of disc. k. S8 of male (Fig. 16h) with apex broadly emarginate medially with a lobe on each side; longitudinal sclerotization usually absent. l. Apex of gonocoxite of male with two plate-like carinae, basal one running dorsoventrally and apical one positioned laterally (horizontally) (Figs. 16j, k) [lateral carina absent in *urbana* (Figs. 16c, e)]. m. Gonostylus of male 6-15 times as long as wide [that of *boharti* short, 2.5 times as long as wide (Fig. 40b), that of *borealis* almost absent, represented only by a small bump]. n. Apex of penis valve 1.1-1.7 times as long as wide as viewed apicodorsally, dorsum of apex covered with short hair, ventrally with a round patch of long hair (Fig. 16j) [round patch of short hair in *boharti* (Fig. 40b) and *borealis*]. o. Bridge of penis valve basally emarginate, about 1.5-2.0 times longer than wide. p. Pygidial plate of male absent but apicomedially a shelf-like, broadly emarginate projection present (Fig. 16d); gradular process of T7 of male absent. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose significantly surpassing apex of gonostylus (except *urbana* with sting only attaining apex), 2-3 times longer than length of gonostylus. s. Length 9-16 mm.

Comments. The relationship of *Mystacanthophora* to other subgenera of *Anthophora* remains obscure. Perhaps it is related to *Caranthophora,* which it more or less superficially resembles, but I have found no synapomorphies linking any subgenus to *Mystacanthophora.* It can readily be separated from other subgenera of *Anthophora* by the characters given in the *Diagnosis.*

Etymology. Mystacos (Gr.), the hair upon the upper lip, a prefix referring to the modified setae at the base of the female clypeus, plus *Anthophora,* a name of a related taxon.

Montana Species Group

b. Female with face modified as in subgeneric description or occasionally unmodified. i. S6 of male with a median longitudinal rounded ridge, sometimes weakly developed, with a large lateral tuft of black hair (Fig. 16f); S5 of male modified as indicated in subgeneric description (Fig. 16i). l. Apex of gonostylus as indicated in subgeneric description. r. Sting in repose greatly exceeding apex of gonostylus.

Comments. From a study of the type series of *A. arequipensis* and *escomeli,* it became apparent that *escomeli* is the melanic form of *arequipensis.* The females in the series showed intergradation between the pale-haired *arequipensis* and the all black *escomeli.* There are no morphological differences between the two. Dichromatism is not uncommon in *Mystacanthophora;* there are melanic forms of *hilaris* and *tricolor.*

A noteworthy apomorphy of the flat-faced species is the presence of both micro and macrosetae (Fig. 3a) on the clypeus. Other Anthophorini have only macrosetae.

Biology. North American species of *Mystacanthophora* fly from mid April to October and even to mid December in México. Antillean species fly from May to December. Alayo Dalmau (1973) gave a list of Cuban *Mystacanthophora* and Alayo Soto (1982) gives a brief biology of *A. atrata.* Adult activity of South American species is from October to mid July. Gay (1851) gave a list of Chilean *Mystacanthophora.* The nesting biology of two of the South American *Mystacanthophora* is known: *incerta* (Etcheverry and Valenzuela, 1960) and *paranensis* (Janvier, as *incerta* Janvier, 1955; Michener et al., 1958). In the Old World, the biology of only *borealis* (Popova, 1984) is known.

Included Species. A. (Mystacanthophora) albiceps Friese, *andicola* Schrottky, *arequipensis* Brèthes, *atrata* Cresson, *bahamensis* n. sp., *boharti* n. sp., *borealis* Morawitz, *capistrata* Cresson, *dorsalis* Vachal, *footei* Crawford, *hilaris* Smith, *incerta* Spinola, *montana* Cresson, *paranensis* Holmberg, *pilifrons* Packard, *tricolor* (Fabricius), *versicolor* Friese, and *walshii* Cresson. They occur over most of the United States except the southeastern States. Additionally they are found in the southern areas of British Columbia, Alberta, Saskatchewan and Manitoba. The Antillean species, listed by Friese (1902), occur from the Bahamas and Cuba (but not known from Jamaica) to Saint Vincent. The South American species occur from Mérida, Venezuela, south in the Andean zone to about Santiago, Chile and east across northern and central Argentina to southern Brasil. Old World species, *borealis* and *boharti,* occur in Central Europe and Iran to Siberia.

Urbana Species Group

b. Female with unmodified face. i. S6 of male without a median longitudinal rounded ridge and no lateral tuft of black hair; S5 of male not modified. l. Apex of gonostylus of male with dorsoventral carina less developed and lateral carina absent (Figs. 16c, e). r. Sting in repose almost attaining apex of gonostylus.

Comments and Biology. Among *Mystacanthophora* species, *A. urbana* is the one having the most plesiomorphous characters. The female has an

unmodified face and the male has an unmodified S5, S6 and genitalia. *A. urbana* is at least bivoltine (Mayer and Johansen, 1976), flying from the end of March to mid November.

Included Species. A. (Mystacanthophora) urbana Cresson. Even though it is a "primitive" species, it has the largest range of any North American *Mystacanthophora* — Texas and Nebraska (exclud-

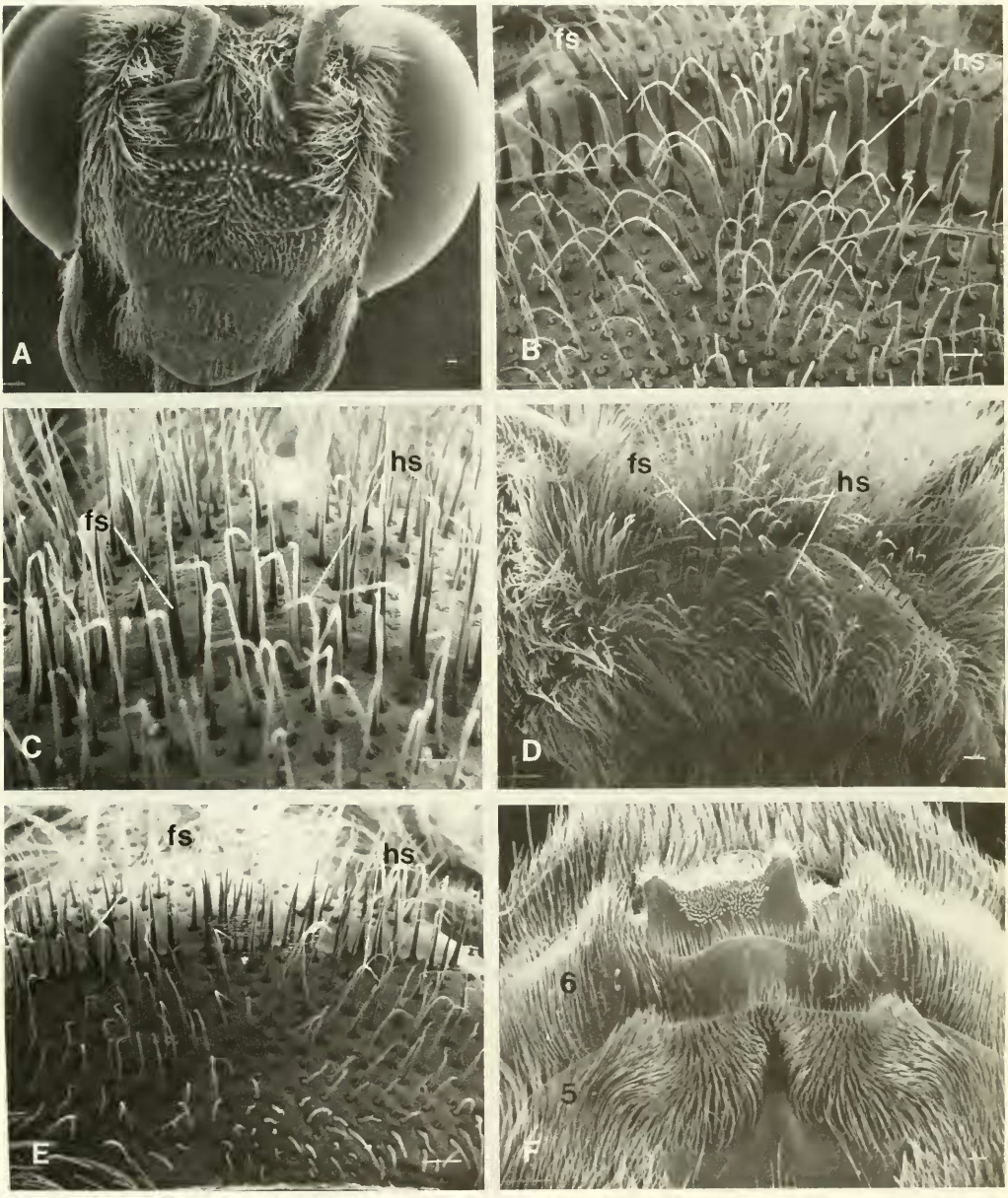


FIG. 17. *Anthophora* subgenus *Mystacanthophora.* Scale lines (on right side) represent .1 mm; fs = flattened or round stout seta. hs = apically hooked seta of pecten. A, B, *Anthophora capistrata* female, face and close up of base of clypeus. C, *A. montana,* base of clypeus of female. D, E, *A. arequipensis* and *A. hilaris,* upper part of clypeus of females. F, *A. walshii,* ventral view of male metasoma showing pattern of pubescence of S5-S6.

ing Kansas and Oklahoma) west to the Pacific Coast (southern British Columbia to Baja California).

Caranthophora new subgenus

Type Species: *Anthophora dufourii* Lepeletier, 1841.

Diagnosis. Clypeus of female with inverted T-shaped pale mark (Fig. 18g) (except the Chinese *A. hedini*); male with midtarsal brush absent, midbasitarsal and middistitarsal brushes well developed (Fig. 18k); posterior margin of inner surface of hind basitarsus with shiny, sparsely setose longitudinal concavity (Fig. 18h); hind tibia and femur of male dilated (Fig. 18i); S7 of male with disc about as wide as long, apodeme short (Fig. 18d); S8 of male broad and short, apicolateral margin with submedian angulate lobe and lateral rounded lobe (Fig. 18c); pygidial plate of male absent, T7 with two submedian, widely separated, apical teeth (Fig. 18j).

Description. a. Flagellar segment 1 of female equal to length of next 2.2-3.0 segments, of male to next 1.2-1.7 segments. b. Face of male with white markings, mandible black (*A. hedini* with mandible white); clypeus of female with inverted T-shaped white mark (Fig. 18g) (brown in *iole,* absent in *hedini*); labrum with pale mark (absent in *A. hedini*). c. Malar space of female 5.5-11.7 times as wide as long, of male 5.0-10.7 times as wide as long; flabellum with several apical finger-like lobes; mentum simple, without anterior tooth on basal third, mentum about .6 as long as prementum; paraglossa about .7 as long as stipes. d. Midtarsal brush of male absent. e-f. Midbasitarsal and middistitarsal brushes of male well developed (Fig. 18k). g. Hind basitarsus of male with or without basal tooth; basitarsus greatly flattened, outward surface broadly concave (Fig. 18i); inner hind basitarsal brush of male not extending to posterior margin, leaving a shiny, sparsely setose longitudinal concavity (Fig. 18h); hind tibia and femur dilated (Fig. 18i). h. Basitibial plate of male absent. i. S6 of male with apex broadly but shallowly emarginate, sometimes with lateral projection on apical margin (only in *dufourii*) (Fig. 18f). j. S7 of male apically broad, narrowly emarginate medially, sometimes with median projection (Fig. 18d); apicolateral margin with smaller dorsal lobe and slightly basal to it a larger ventral lobe, in profile as in Figure 18e; base of disc with lateral dark sclerotized area or tooth; apodeme extremely short, .3-.4 as long as length of disc (Fig. 18d). k. S8 of male apically with 4 projections, submedian pair strongly developed and angulate, lateral pair strongly to weakly developed and rounded (Fig. 18c); longitudinal sclerotization absent. l. Apex of gonocoxite of male, viewed laterally, with 3 projections; gonostylus not borne on any of these projections (Fig. 18b). m. Gonostylus of male, short, flat to round in cross section, 4.8-10.0 times longer than wide. n. Apex of penis valve narrow and small, 2.4-2.8 times as long as wide viewed apicodorsally (Fig. 18a). o. Bridge of penis valves simple, not emarginate, short and wide basally, 0.9-1.5 as long as wide. p. Pygidial plate of male absent; T7 of male apicomedially with 2 widely separated submedian teeth, their length .2-.3 as long as distance between their outer bases (Fig. 18j); gradular process of T7 absent. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose usually not quite attaining apex of gonostylus (slightly surpassing in *iole*), 2.0-2.5 times length of gonostylus. s. Length 8.5-17.8 mm.

Etymology. Cara (Gr.), face, a prefix referring to the pale marks on the face of the female, plus *Anthophora.*

Comments. Caranthophora apparently is most closely related to *Heliophila* from which its females can be separated by having the posterior margin of the hind tibia with a band of plumose hairs. The males are readily separated by a dilated hind femur and tibia and flattened basitarsus that bears on its anterior surface a basal and an apical tooth, by "brushes" of hair on the midtibia and midtarsus, and by other male characters given in the *Diagnosis.*

Included Species. A. (Caranthophora) dufourii Lepeletier, *hedini* Alfken, *iole* Bingham, *kneuckeri* Alfken, *pubescens* (Fabricius), and *spinacoxa* n. sp. The six species are more or less disjunct. They are found in the Mediterranean and eastern European areas to northern India and eastern China.

Subgenus *Paramegilla* Friese

Paramegilla Friese, 1897, pp. 18 and 25.

Type species: *Apis ireos* Pallas, 1773, designated by Sandhouse, 1943, p. 584.

Solamegilla Marikovskaya, 1980, pp. 650-652. **New Synonym.**

Type species: *Anthophora prshewalskii* Morawitz, 1880 (by original designation).

Diagnosis. Hind basitarsus of male usually with an anterior bump to well developed tooth and/or flattened (Figs. 19g, 20g, j, o); apical margin of S6 of male flexed ventrally, at base of deflection a transverse concavity (Figs. 19h, 20e); male with S7 apically with two or four lobes (Figs. 19e, 20d) and of S8 apicolaterally angulate, lateral margin weakly angulate to almost straight (Figs. 19c, 20c); pubescence of metasoma appressed (Fig. 21e), densely semi-erect or with apical bands interrupted medially (Figs. 21c, d); T7 in male variable but distinctive with two lateral teeth (Figs. 19d, 20h, i, k-m) and pygidial plate without carinate margins [except *A. balneorum* (Fig. 20n) and *femorata*].

Description. a. Flagellar segment 1 of female equal to length of next 2.2-4.0 segments, of male to next 1.5-3.2 segments. b. Face of male with creamy white to light yellow, occasionally bright yellow markings; of female black, sometimes with

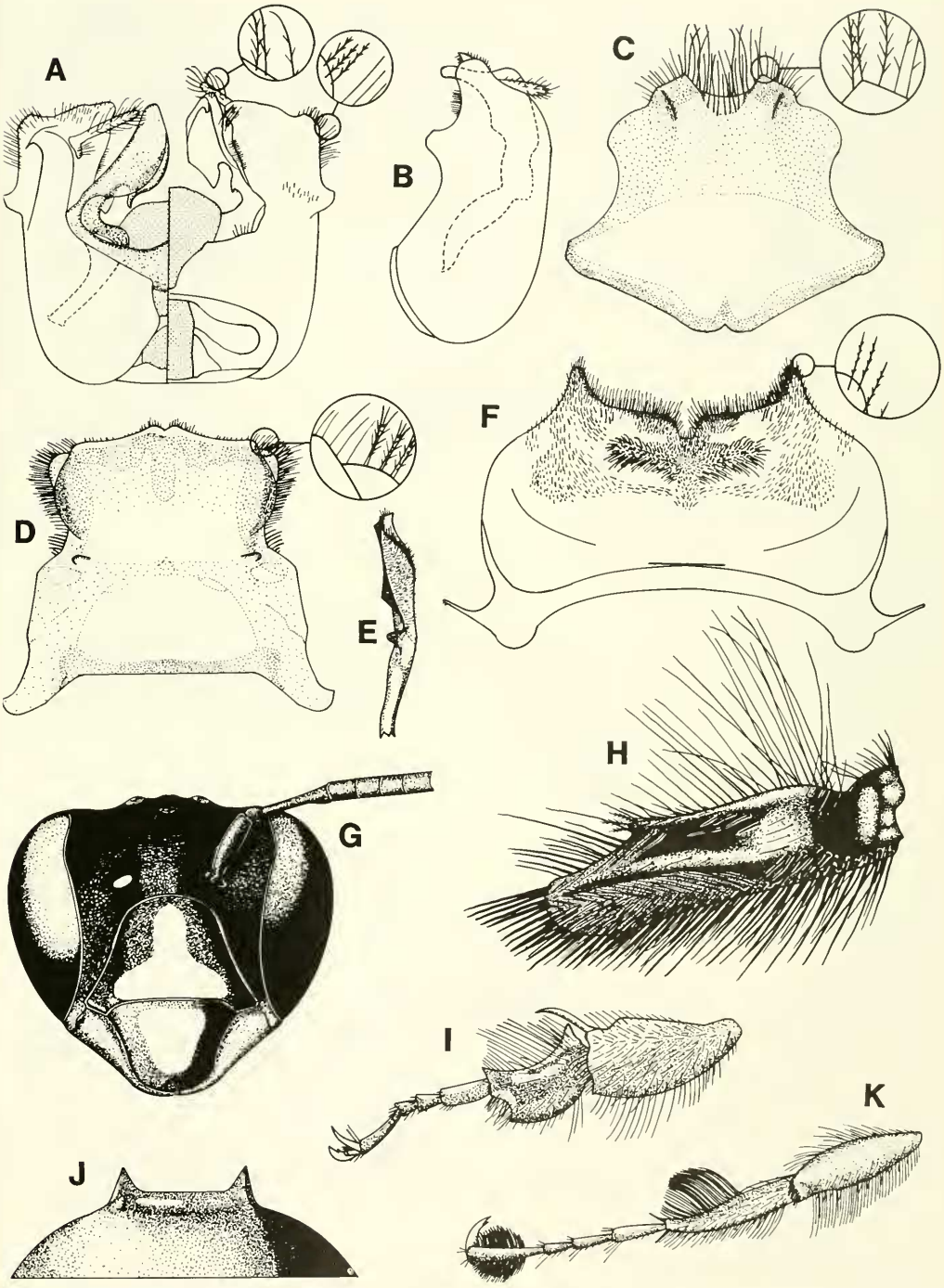


FIG. 18. *Anthophora (Caranthophora) dufourii,* all male except G. A, B, Genital capsule, dorsoventral and side views. C, S8, ventral view. D, E, S7, ventral and side views of disc. F, S6, ventral view. G, Head. H, Hind basitarsus, inner surface. I, Hind leg, outer surface. J, Apex of T7, dorsal view. K, Midleg, outer view.

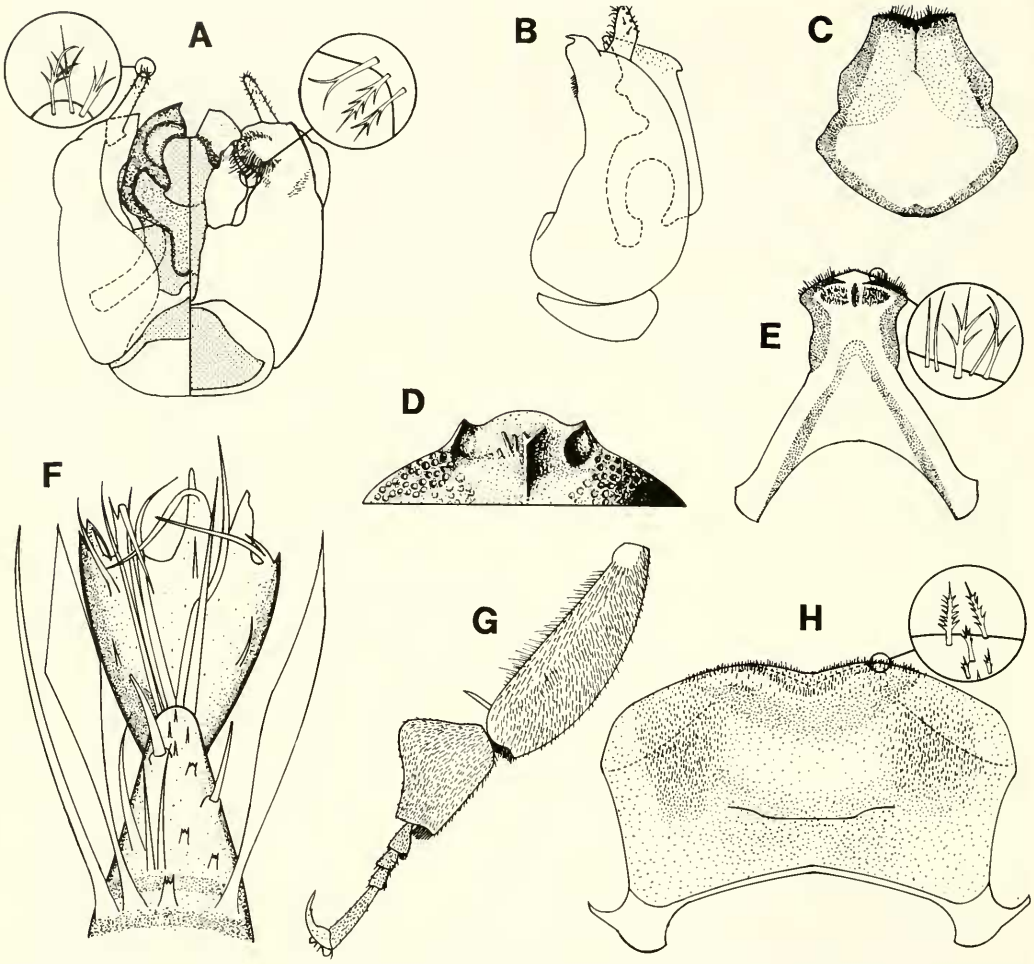
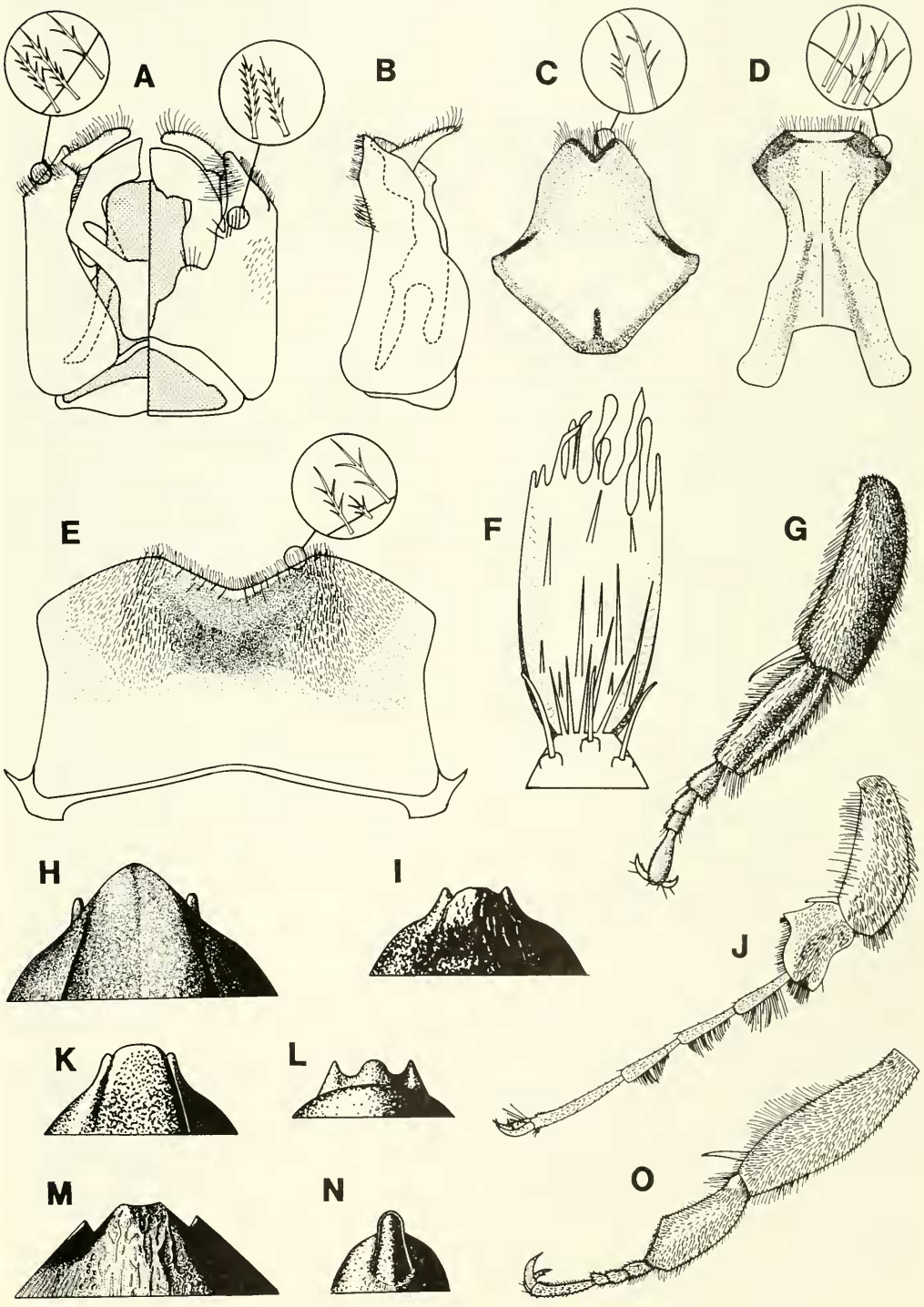


FIG. 19. *Anthophora (Paramegilla) ireos,* male. A, B, Genital capsule dorsoventral and side views. C, S8, ventral view. D, Apex of T7 (hair omitted), dorsal view. E, S7, ventral view. F, Flabellum, anterior view. G, Hind leg, outer view. H, S6, ventral view.

pale marks on clypeus labrum and mandibles. c. Malar space of female 5.5-13.0 times as wide as long; of male 5.7-13.0 times as wide as long; flabellum with several apical finger-like lobes; mentum near basal third simple, without anterior tooth, mentum about .5-.6 as long as prementum; paraglossa about .8 as long as stipes. d-f. Midleg with brushes of male absent. g. Hind basitarsus of male almost always with an anterior bump to a well developed tooth .35-.80 as wide basally as long (Figs. 19g, 20g, j, o) or with an anterior longitudinal ridge (simple in *A. balneorum, A. erubescens,* and *A. ferruginea*); hind tarsus of male sometimes elongated (Fig. 20j); hind tibia and femur of male often dilated, bulbous (Fig. 20j). h. Basitibial plate of male usually absent (present in *A. balneorum, A. eburnea, A. superans,* weakly developed in *A. ferruginea*). i. Apex of S6 of male broadly to narrowly emarginate medially (margin entire in *A. superans*), apical margin

FIG. 20. *Anthophora* subgenus *Paramegilla,* males. A-H, *A. (P.) basalis.* A, B, Genital capsule, dorsoventral and side views. C-E, S8, S7 and S6, ventral views. F, Flabellum, anterior view. G, Hind leg, outer view. H, Apex of T7, dorsal view. I, Apex of T7 of *A. (P.) semirufa,* dorsal view. J, Hind leg of *A. (P.) gracilipes,* outer view. K-N, Apex of T7 of *A. (P.) valga, A. (P.) dubia, A. (P.) vidua,* and *A. (P.) balneorum,* dorsal views. O, Hind leg of *A. (P.) centriformis,* outer view. Apices of T7 (H, I, K-N) are shown with hairs omitted.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ventrally flexed with weak to strong concave transverse depression (Figs. 19h, 20e); S4 of male sometimes with a median "crown" of dense hair (Fig. 21f). j. S7 of male apicomedially emarginate, entire or produced, apically with 2-4 lobes; base of disc without lateral protuberance though weakly sclerotized area sometimes present; apodeme short, .34-.78 times as long as disc (Figs. 19e, 20d) (long in *A. alternans, A. gracilipes,* and *A. maculigera,* 1.2-1.7 times). k. Apex of S8 of male slightly to deeply emarginate medially and angulate; lateral margin more or less straight (Figs. 19c, 20c); longitudinal sclerotization almost always present. l. Apex of gonocoxite of male relatively simple, in profile weakly bilobed to trilobed (Fig. 18b). m. Gonostylus of male usually flattened, 2.0-8.3 times as long as wide (Figs. 19a, b, 20a, b) (gonostylus reduced to small bump in *A. gracilipes*). n. Apex of penis valve 1.0-2.4 times as long as wide as viewed apicodorsally. o. Bridge of penis valve basally emarginate (except *A. femorata, A. ferruginea,* and *A. superans*), length 1.4-2.6 times as long as wide (Figs. 19a, 20a). p. Male usually with well developed pygidial plate almost always with a basal, lateral tooth .06-.20 as long as distance between their outer bases (Fig. 20h), plate without carinate margins [except *A. balneorum* and *A. femorata* (Fig. 20n)], sometimes only with apex narrowly to widely emarginate forming submedian teeth (Fig. 20l), sometimes with median longitudinal carina (Fig. 19d); gradular process of T7 of male absent; metasoma often with appressed (Fig. 21e) or dense semi-erect pubescence or apical bands of hair interrupted medially (Figs. 21c, d). q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose attaining to surpassing apex of gonostylus (surpassing as far as .43 gonostylar length); sting 1.8-2.7 times length of gonostylus. s. Length 9.5-24 mm.

Biology. Species of *Paramegilla* fly from March to August in the Old World, March to early May in the southwestern U. S. The nesting biologies of three Eurasian species of *Paramegilla* have been reported by Ferton (1902, *A. balneorum*) and Marikovskaya (1970, *fedchenkoi* [as *fedtschenkoi*] and *vestitella* [as *vestita*]).

Comments. Paramegilla is closely related to *Melea* and *Anthophoroides*. It differs from *Melea* in the female by having the hind tibia with a blunt posterior distal process and the posterior margin with band of plumose hair (except *A. larvata,* etc.). The males are separated by having the apicolateral margin of S7 rounded or angulate, not with a large rounded lobe, and the base of S8 coming to a simple point, not trilobed. *Paramegilla* is separated from *Anthophoroides* most easily by distribution since *Anthophoroides* is Nearctic and *Paramegilla* is almost completely Palearctic and Ethiopian. The two species of *Paramegilla* that occur in the southwestern U. S. are large (about 14 mm.) and with appressed hair whereas *Anthophoroides* is small (10-12 mm.) and usually with erect to semi-erect hair. *Anthophoroides* and *Melea* have an anterior tooth near the basal third of the mentum and different male terminalia than *Paramegilla.* There are many species groups within *Paramegilla* not discussed here. The best discussion and illustration of structures of *Paramegilla* was by Marikovskaya (1980). Many *Paramegilla* males have the inner orbits more or less parallel (Fig. 21a) but one African group has the inner orbits diverging above and below (Fig. 21b) as in *basalis.* Another group in Central Asia has a peculiar "crown" of hair on S4 of males (Fig. 21f). Many species have medially interrupted apical hair bands on the terga (Figs. 21c, d). A noteworthy species group (e.g., *A. ambitiosa, femorata, larvata*) includes the only known *Paramegilla* in which the females lack plumose hair along the posterior margin of the hind tibia and in which the second segment of the maxillary palpus is about equal in length to the third.

Marikovskaya (1980) separated *Solamegilla* from *Paramegilla* based upon the wide cheeks, strongly projecting clypeus, elongated flagellomere 1, the strongly elongated apicolateral lobes of S7 and S8 and the presence of teeth along the sides of the pygidial plate of males. The wide cheeks are of no value in separating *Solamegilla* from *Paramegilla;* the width of the genae varies greatly among the species of both taxa as she envisioned them. Similarly, the projection of the clypeus varies widely. The type species of *Paramegilla (A. ireos)* and *Solamegilla (prshewalskii)* have the same clypeal protuberance in profile, that is .6 the protuberance of the eye. Marikovskaya used the length of the "second flagellar segment" (= first flagellomere) to separate the taxa. In the species that Marikovskaya placed in *Solamegilla,* the first male flagellomere is equal in length to the next 1.5 segments *(deserticola)* to 3.0 segments *(onosmarum),* the first female flagellomere is equal in length to the next 2.7 segments *(deserticola)* to 4.0 segments (*onosmarum* and *abramowi*). In *Paramegilla* (sensu Marikovskaya) the range in the male is 1.5 segments *(ireos)* to 2.9 *(vidua),* in the female 2.2 *(olgae)* or 2.3 segments *(ireos)* to 3.3 segments *(gracilipes).* The length of the first flagellomere does not separate *Solamegilla* from *Paramegilla* (sensu Marikovskaya) because there is a continuum of lengths which widely overlap between her two taxa. Marikovskaya (1980) also stated that another distinguishing character is the "strongly elongated lateral subapical lobes of 7th sternite and apex of 8th sternite" although in her diagnosis of *Solamegilla* she records this sternum as "oblong, its subapical lobes varying from

rounded, merging with apex, to strongly laterally expanded and tapered in the following series of species. . . . Subapical lobes of 8th abdominal sternite not developed, its apex varying from medium width to narrow and strongly elongated in the following sequence of species. . . ." The species of *Paramegilla* (sensu Marikovskaya) show the same variation in the apices of S7 and S8. The last character of the male, namely the presence of teeth on the pygidium, is common in both her *Paramegilla* and *Solamegilla,* thus not of value in separating them. For these reasons, I have syn-

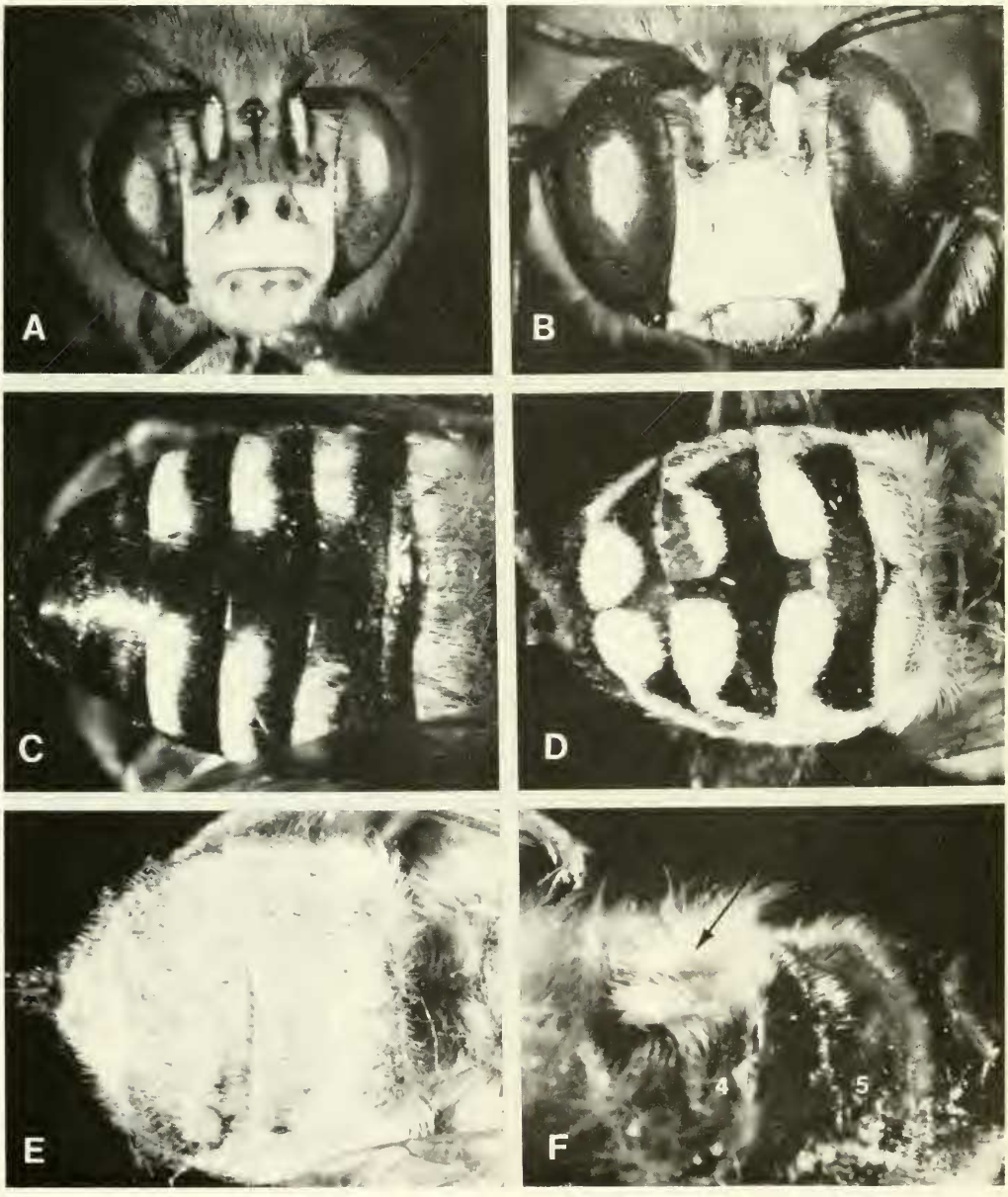


FIG. 21. *Anthophora* subgenus *Paramegilla.* A, *A. gracilipes,* male, frontal view of head. B, *A. semirufa,* male, frontal view of head. C, *A. ireos,* male, dorsal view of metasoma. D, *A. olgae,* female, dorsal view of metasoma. E, *A. martensi,* female, dorsal view of metasoma. F, *A. deserticola,* male, lateroventral view of metasoma, arrow indicates midventral "crown" of hair on S4, and numbers sterna.

onymized *Solamegilla* under *Paramegilla.*

Some unique secondary sex characters are noteworthy in *Paramegilla* such as the somewhat serrate antennae of the male of *A. astragali* (Fig. 7c) and the clubbed antennae of the male of *clavicornis* (Fig. 7d).

Included Species. A. (Paramegilla) abramowi Fedtschenko, *alternans* (Klug), *ambitiosa* Alfken, *armata* Friese, *astragali* Morawitz, *balneorum* Lepeletier, *barbipes* Fedtschenko, *basalis* Smith, *blanda* Pérez, *bogutensis* (Marikovskaya), *centriformis* Cresson, *christofi* Morawitz, *clavicornis* Fedtschenko, *concolor* Alfken, *curvicornis* Hedicke, *deserticola* Morawitz, *dubia* Eversmann, *eburnea* Radoszkowsky, *epichariformis* Gribodo, *excelsior* Strand, *fedchenkoi* Radoszkowsky, *femorata* (Olivier), *ferruginea* Lepeletier, *flavescens* Fedtschenko, *flavicornis* Morawitz, *fulvicauda* Timberlake, *fulvipes* Eversmann, *furcotibialis* Wu, *glasunovi* Morawitz, *glaucopis* Friese, *gracilipes* Morawitz, *harmalae* Morawitz, *hirtiventris* Friese, *inclyta* Walker, *ireos* (Pallas), *irregularis* Dours, *kaufmanni* Fedtschenko, *larvata* Giraud, *leonis* Cockerell, *leucopyga* Friese, *maculigera* Priesner, *martensi* Fedtschenko, *melanopyga* Fedtschenko, *meridionalis* Fedtschenko, *mucoriventris* Friese, *olgae* Fedtschenko, *onosmarum* Morawitz, *perezi* Morawitz, *planca* Pérez, *podagra* Lepeletier, *ponomarevae* Brooks, *prshewalskii* Morawitz, *quadricolor* (Erichson), *raddei* Morawitz, *sagemehli* Morawitz, *semirufa* (Friese), *solskyi* Fedtschenko, *spinipes* (Friese), *superans* Walker, *syriaca* Friese, *tarsidens* Fedtschenko, *tedshenensis* Radoszkowsky, *trochanterica* Morawitz, *valga* (Klug), *vestitella* Brooks, and *vidua* (Klug). This subgenus is widespread in Eurasia and Africa, with two species, *centriformis* and *fulvicauda,* in the western United States.

Subgenus *Melea* Sandhouse

Anthemoessa Robertson, 1905, p. 372 (nec Agassiz, 1847).

Type species: *Anthophora abrupta* Say, 1837. Monobasic and original designation.

Melea Sandhouse, 1943, p. 569 (new name for *Anthemoessa* Robertson).

Type species: *Anthophora abrupta* Say, 1837. Autobasic.

Diagnosis. Hind tibia of female with hairs of posterior margin simple, not plumose (Figs. 10e, 22h); hind basitarsus of female with posterior distal process acute (Figs. 22h, 23c); S6 of female with subapical tooth; hind basitarsus of male with anterior margin toothed or angulate (Fig. 22i), male S7 apicolaterally with a large rounded lobe (Fig. 22e) and S8 apically narrowed and basally trilobed (Fig. 22d); mentum near basal third with anterior tooth (Fig. 22k); palearctic species with well to moderately developed malar space as shown in Figure 25h.

Description. a. Flagellar segment 1 of female equal to length of next 2.4-3.0 segments together, of male to next 1.3-1.7 segments. b. Face of male with yellow, of female black; mandible of male with pale mark. c. Malar space of female 3.2-7.8 times as wide as long, of male 2.0-8.4 times as wide as long; flabellum apically with several finger-like lobes; mentum near basal third with anterior tooth (Fig. 22k), mentum about .7-.8 as long as prementum; paraglossa .6-.7 as long as stipes. d-f. Midleg of male with brushes absent. g. Hind basitarsus of male laterally flattened with anterior tooth or ridge (Fig. 22i); hind tibia of female without posterior margin of plumose hair (Fig. 22h), hind basitarsus with distal process acute (Figs. 22h, 23c). h. Basitibial plate of male absent. i. S6 of male apicomedially weakly to strongly emarginate with lightly sclerotized apical area; lateral depression present (Fig. 22f). j. S7 of male apically rounded not emarginate, with large rounded lateral lobe; base of disc without protuberances or dark sclerotized lateral area; apodeme 0.7-1.1 times as long as length of disc (Fig. 22e). k. S8 of male apically with two acute lateral projections, basally trilobed; longitudinal sclerotization absent (Fig. 22d). l. Apex of gonocoxite of male relatively simple, with one long, apical projection and one or two lateral, weakly projecting protuberances (Figs. 22b, c). m. Gonostylus of male flattened, 5-8 times as long as wide. n. Apex of penis valve 1.2-1.7 times as long as wide viewed apicodorsally (Figs. 22b, c). o. Bridge of penis valve basally simple, not emarginate, 0.8-1.5 times as long as wide. p. Pygidial plate of male absent; T7 with two blunt submedian teeth .10-.15 as long as distance between their outer bases; gradular process of T7 of male absent (Fig. 22j); S6 of female with subapical tooth. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose not attaining apex of gonostylus, twice as long as gonostylus. s. Length 13-17 mm.

History. In 1905 Robertson proposed the generic name *Anthemoessa* for *Anthophora abrupta* Say, using the greater breadth of submarginal cell 3 as the principal key character for the female, and the toothed hind basitarsus for the male. The name *Anthemoessa* had been used previously by Agassiz (1847) as an emendation for a Lepidopteran genus, hence the replacement name *Melea* was proposed by Sandhouse (1943).

Timberlake (1951) believed that *Anthophoroides* was applicable not only to *Anthophora vallorum* (Cockerell) but also to *Melea.* Knowing that the breadth of submarginal cell 3 was valueless, he relied mainly on the length of the first flagellomere, the amount of development of the malar space, and sex-limited characters such as the presence or absence of a tooth on the hind basitarsus and a fringe of dense, often long hair on the middle tarsus of the male to separate

Anthophora s. str. (in his sense) from *Anthophoroides*. Timberlake's idea of *Anthophora* s. str. did not include *Heliophila (=Micranthophora), Amegilla,* or *Clisodon* which he considered genera. Timberlake was the first to recognize the similarities between *Melea* and *Anthophoroides*.

Comments. Melea is most closely related to *Anthophoroides*. Even though the two share derived characters such as the short first flagellomere, the mentum with an anterior tooth near the basal third, the hind basitarsus of the male with an anterior tooth, and similar male terminalia as well as plesiomorphous male characters such as lack of midtarsal, midbasitarsal, and middistitarsal brushes, they are distinct groups. *Melea* can be separated from *Anthophoroides* in the females by the hind tibia with the scopal hairs all simple, S6 with a subapical tooth and the posterior distal process of the hind tibia acute. The males can be separated by their larger size (13-17 mm.), the widely diverging rather than almost parallel apodemes of S7, the trilobed rather than rounded base of S8, and the blunt rather long and acute tooth of the hind basitarsus.

Biology. Melea fly from March to August or September. Several derived biological characters

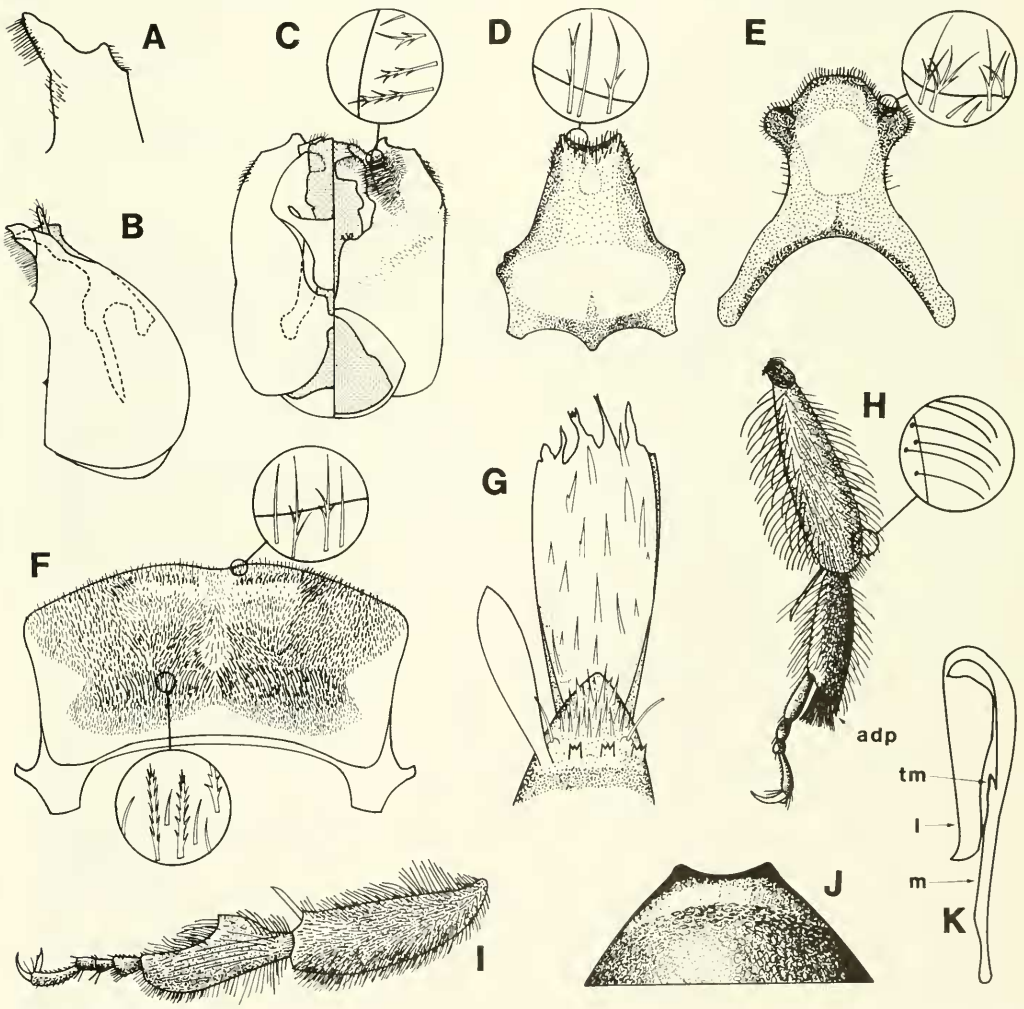


FIG. 22. *Anthophora* subgenus *Melea*. adp = acute distal process of female hind tibia, l = lorum, m = mentum, tm = tooth of mentum. A, *A. (M.) plagiata,* apex of gonocoxite, ventral view of right side. B-K, *A. (M.) abrupta*. B, C, Genital capsule, side and dorsoventral views. D-F, S8, S7 and S6 of male, ventral views. G, Flabellum, anterior view. H, I, Hind leg of female and male, outer views. J, Apex of male T7 (hair omitted), dorsal view. K, Lorum and mentum, side view.

are unique to *Melea* separating it from other taxa in *Anthophora*. These include construction of turrets over the nest entrances and the apparent loss of stinging behavior (Brooks, 1983). All of the species of *Melea* are apparently mimics of bumble bees.

Bomboides Species Group

c. Malar space of female 5.5-7.8 times as wide as long (similar to Fig. 12e), of male 5.7-8.4 times. g. Hind basitarsus of male with large tooth on basal half, tooth .42-.54 as wide basally as long (Fig. 22i). l. Apex of gonocoxite of male with a lateral tooth in addition to apical projection (Fig. 22b).

Comments and Biology. This species group is mainly North American with one Chinese species. Brooks (1983) has discussed the systematics and reviewed the literature on and biology of the nearctic species of *Melea* as the Bomboides species group. Additionally, Norden and Scarbrough (1982) reported on the biology of *A. abrupta*. The males of *A. abrupta* and *nigrifrons* are unique among all other species of Anthophorini in that the labrum has an apical brush of fine flattened adsorptive hairs. The males of *abrupta* chew parsnip (*Pastinaca sativa* L.) tissue, collect the juice in the labral brush, presumably mixing it with mandibular gland secretion, and apply it to objects outlining their territorial paths (Norden and Batra, 1985).

Included Species. A. (Melea) abrupta Say, *bomboides* Kirby, *nigrifrons* Cockerell, and *occidentalis* Cresson. *A. nigrifrons* occurs in southeastern China; the other species are North American and they range far into the Arctic and are found throughout the United States, British Columbia and most of Alberta. With *Clisodon* and *A. (Mystacanthophora) borealis,* they are the only boreal *Anthophora.*

Plagiata Species Group

c. Malar space of female about 3 times as wide as long, of male 2.0-3.8 times (similar to Fig. 25h). g. Hind basitarsus of male with small tooth on apical half, tooth .33-.37 as wide basally as long. l. Apex of gonocoxite of male with two lateral teeth in addition to apical projection (Fig. 22a).

Biology. Important papers concerning palearctic *Melea* are about *A. plagiata* (reported as *parietina*) such as Banaszak (1971), Cros (1936, reported as *romandii*), Marikovskaya (1970), Móczár (1961a, b), Nielsen (1902), Radović and Krunić (1977), Tiede (1920), Verhoeff (1892a) and Wesenburg-Lund (1890). *A. plagiata* may have potential as a manageable pollinator of vetches such as *Vicia villosa* (Wójtowski, 1964). The only other palearctic species whose biology is known is *A. ferreola* (Piel, 1935).

Included Species. A. (Melea) cinerithoracis Wu, *ferreola* Cockerell, *mangkamensis* Wu, *obtusispina* Wu, and *plagiata* (Illiger). The range is from central Europe to China.

Subgenus *Anthophoroides* Cockerell and Cockerell

Anthophoroides Cockerell and Cockerell, 1901, p. 48. Type species: *Podalirius vallorum* Cockerell, 1896. Monotypic and original designation.

Diagnosis. Length 10-13 mm; male with spine on hind tibia anteroapically, with a tibial spur inserted on apical third of spine (Figs. 24i, j); hind basitarsus of male with anterior tooth (Figs. 24i, j); S7 of male apicolaterally with wide rounded lobe, apodemes almost parallel to each other (Fig. 24 d); S8 apicolaterally with angulate submedian lobe and rounded lateral lobe, basally rounded, spiculum long, projecting at right angle from disc (Fig. 24g); gonocoxite of male darkly sclerotized apically (Fig. 24f); mentum near basal third with anterior tooth like species of *Melea* (Fig. 22k).

Description. a. Flagellar segment 1 of female equal to length of next 2.50-3.33 segments together; of male to next 1.33-1.50 segments. b. Face of male with white (yellow in *A. vallorum* and *californica*), of female black (except white marks on *signata*). c. Malar space of female 6.3-8.7 times as wide as long (*vallorum* 13 times), of male 7.0-11.3 times as wide as long; flabellum apically with several finger-like lobes; mentum with anterior tooth near basal third (Fig. 22k), mentum about .5-.7 as long as prementum; paraglossa about .5-.8 as long as stipes. d-f. Midleg with brushes of male absent. g. Hind basitarsus of male with anterior tooth, upper anterior margin of tooth straight to curved (Figs. 24i, j); hind tibia of male dilated with anterior, apical spine, one tibial spur inserted on spine near apex (Fig. 24j); hind femur of male usually dilated, bulbous (Fig. 24j). h. Basitibial plate of male absent. i. S6 of male with apex narrowly emarginate medially, lightly sclerotized; lateral depression present (Fig. 24a). j. S7 of male apically round with broad lateral lobe, profile as in Figure 24e; disc basally without protuberances or dark sclerotized areas; apodeme 1.0-1.3 as long as length of disc (Fig. 24d). k. S8 of male apically with dark sclerotized, ventrally projecting, submedian pair of lobes (Fig. 24g), apicolateral corner weakly developed and rounded, profile of S8 as in Figure 24h; longitudinal sclerotization absent (Fig. 24g). l. Apex of gonocoxite of male apparently simple, though apical lobe with subapical lateral lobe weakly developed, sometimes gonocoxite appearing weakly bilobed, laterally angulate and dark sclerotized (Figs. 24c, f). m. Gonostylus of male 5.0-6.7 times as long as wide. n. Apex of penis valve small, 0.9-1.6 times as long as wide as viewed apicodorsally. o. Bridge of penis valve

basally simple, 0.75-1.10 times as long as wide (Fig. 24f). p. Pygidial plate of male absent; T7 of male with two short submedian teeth .14-.26 as long as distance between their outer bases (Fig. 24b); gradular process of T7 of male absent. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose not attaining to surpassing apex of gonostylus, 2.2-3.0 length of gonostylus. s. Length 10-13 mm.

Comments. T. D. A. and W. P. Cockerell named *Anthophoroides* because of the five-segmented maxillary palpi. This character is only of value at the specific level, being found also in *A. (Paramegilla) fulvicauda* and in many *Heliophila.* Timberlake (1951) included species of *Melea* with *Anthophoroides* (see *Comments* under *Melea*). *Anthophoroides* is most closely related to *Melea* and its separation from that subgenus is discussed in the *Comments* on *Melea.*

Biology. Species of *Anthophoroides,* a New World subgenus, are xerophilic. Linsley (1942) gave a detailed account of the biology of *A. linsleyi.* Gilliam et al. (1984) analyzed the microbial fauna of an undescribed species of *Anthophoroides.* The territorial behavior of the males of *Anthophoroides* is the same as that of *Melea* in that territories with distinct boundaries, usually enclosing host plants, are defended against conspecific males. The females of *Anthophoroides* nest aggregatively in earthern banks except *signata* which nests in dead Joshua tree stumps *(Yucca)* (R. Snelling, pers. comm.) and possibly also in the ground (Brooks, unpublished). They are generally polylectic though *phaceliae* is oligolectic on *Phacelia* (Hydrophyllaceae).

The species which inhabit the regions of the Sonoran and Colorado desert are probably univoltine but possibly bivoltine. There is a normal spring brood(s?) from February (two records in January) to mid July. In those dry areas which have mid to late summer rains such as southeastern Arizona, *californica* has a second brood. *A. marginata,* the only truly neotropical species, is seasonal in southwestern Arizona and probably in the seasonally dry tropical areas of México but may be multivoltine in other Mexican and Cen-

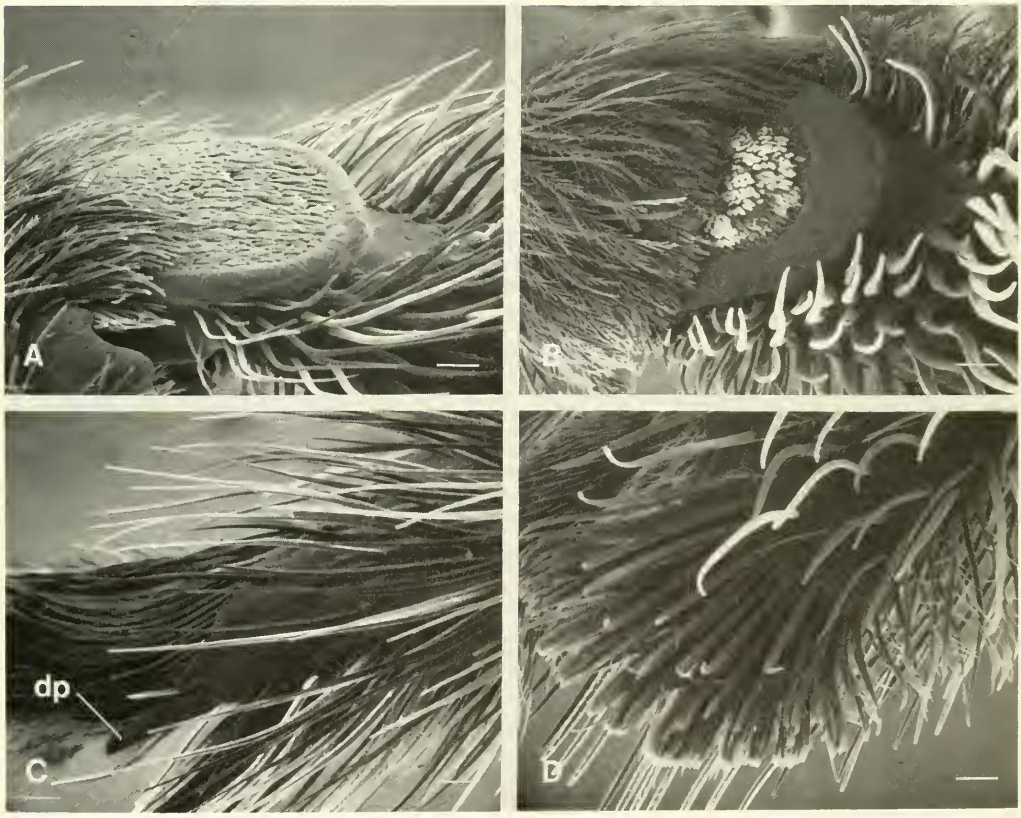


FIG. 23. *Anthophora* subgenera *Melea* and *Mystacanthophora,* females. Scale lines (on right side) represent .1 mm; dp = posterior distal process. A, B, Basitibial plates of *Anthophora (Melea) abrupta* and *A. (Mystacanthophora) capistrata.* C, D, Outer view of apex of hind basitarsus, *A. (Melea) abrupta* and *A. (Mystacanthophora) capistrata.*

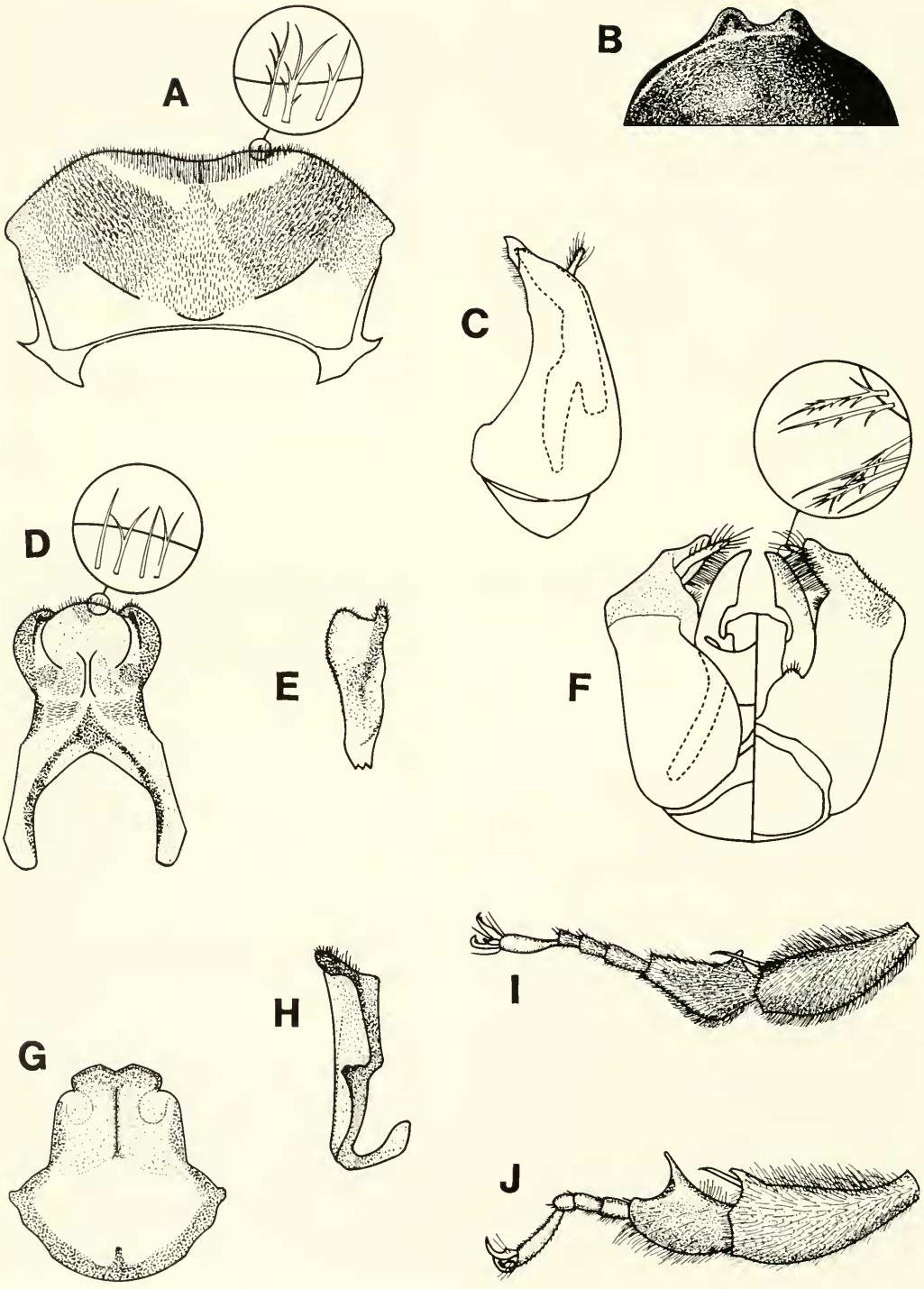


FIG. 24. *Anthophora* subgenus *Anthophoroides,* males. A-I, *A. (A.) vallorum.* A, S6, ventral view. B, Apex of T7 (hair omitted), dorsal view. C, Genital capsule, side view. D, E, S7, ventral and side views of disc. F, Genital capsule, dorsoventral view. G, H, S8, ventral and side views. I, Hind leg, outer view. J, Hind leg of *A. (A.) californica,* outer view.

tral American areas.

Included Species. A. (Anthophoroides) californica Cresson, *linsleyi* Timberlake, *marginata* Smith, *phaceliae* n. sp., *signata* n. sp., *vallorum* (Cockerell), and six undescribed species. They range from Colorado and Texas west to southern Oregon and California, south through México (including Baja California) to Honduras. *A. californica* and *marginata* are the only two species of the twelve which range into the neotropics.

Subgenus *Anthomegilla* Marikovskaya

Anthomegilla Marikovskaya, 1976a, p. 55.

Type species: *Anthophora arctica* Morawitz, 1883. Original designation.

Diagnosis. Malar space well developed, about twice as wide as long (Fig. 25h); male with apically trilobed labrum (Fig. 25i); apodemes of S7 of male short, widely spaced and diverging (Fig. 25e); S8 of male with long apodemes and spiculum projecting anterodorsally in the same plane as disc (Figs. 25b, c); apex of penis valve without fine, small hairs; female with hairs of posterior margin of hind tibia simple (similar to Fig. 10e); flabellum apically entire, apical half to two-thirds narrow and elongate (Fig. 25d).

Description. a. Flagellar segment 1 of female equal to length of next three to four segments together, of male to next 2.0-2.5 segments. b. Face of male with light yellow-white; face of female black; apical margin of male labrum trilobed, median lobe emarginate (Fig. 25i). c. Malar space of female about 1.7 times as wide as long, of male 1.6-2.0 times as wide as long (Fig. 25h); mentum about .7 as long as prementum,

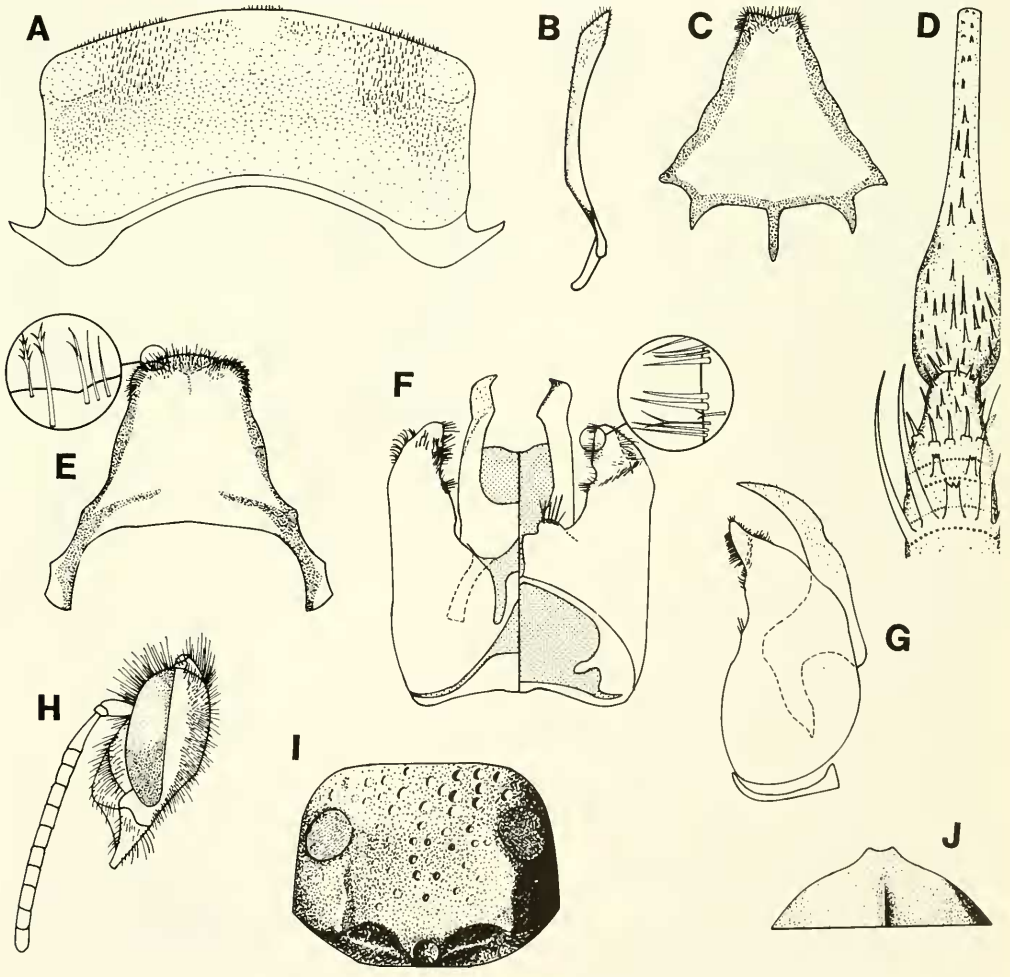


FIG. 25. *Anthophora (Anthomegilla) arctica,* male. A, S6, ventral view. B, C, S8, side and ventral views. D, Flabellum, anterior view. E, S7, ventral view. F, G, Genital capsule, dorsoventral and side views. H, Head, side view. I, Labrum. J, Apex of T7 (hair omitted), dorsal view.

without anterior tooth near basal third; paraglossa about .7-.9 as long as stipes; flabellum apically entire, distal half to two-thirds narrowed, elongate and almost parallel-sided (Fig. 25d). d-f. Midleg with brushes of male absent. g. Hind basitarsus of male simple; female with hairs of longitudinal posterior zone on hind tibia simple (similar to Fig. 10e). h. Basitibial plate of male absent. i. S6 of male apically entire, almost all hair simple except a few apicolateral hairs (Fig. 25a). j. Apex of S7 of male rounded, apicolateral margin weakly developed, apodeme .9 length of disc; base of disc without lateral protuberance or dark sclerotized areas (Fig. 25e). k. S8 of male apicolaterally angulate, longitudinal sclerotization absent, apodemes and spiculum long, both spine-like, projecting anterodorsally and in the same place as the disc (Figs. 25b, c). l. Apex of gonocoxite of male simple, with one blunt projecting lobe as viewed in profile (Fig. 25g). m. Gonostylus of male essentially absent (completely lost in *A. latigena*), only the base remaining as a blister with hairs on inner surface of gonocoxite (Fig. 25f). n. Apex of penis valve 3 times as long as wide as viewed apicodorsally, without hair (Fig. 25g). o. Bridge of penis valve with deep emargination (*latigena* with a pair of protuberances on bridge), emargination .3 times as long as wide (Fig. 25f). p. Pygidial plate of male absent; apex of T7 of male with 2 blunt submedian teeth and basally with a median longitudinal ridge not attaining apical margin; gradular process of T7 of male absent (Fig. 25j). q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose slightly surpassing apex of gonostylus, 1.8 times as long as gonostylus. s. Length of female 11-14 mm, of male 9-13 mm.

Comments. Anthomegilla is closely related to *Rhinomegilla* from which it is separated by the flabellum being apically entire, the apical half to two-thirds narrowed and parallel- sided. The males are separated by the additional characters of the apex of T7 having a median pair of short blunt teeth and S8 with long apodemes and spiculum directed basally.

Marikovskaya (1976a, b) indicated that the volsellae lie free from the gonocoxite in *Anthomegilla.* Upon examination of what she called the volsellae [=ventral lobe of the gonocoxite (Michener, 1944)], I found that their apices are melanized but their bases lightly sclerotized, giving the impression of separation when in fact these structures are connected to the gonocoxites. This condition of apical sclerotization accompanied with basal desclerotization is found in varying degrees in other *Anthophora* but is apparently most highly developed in *Anthomegilla.*

Biology. It appears probable that *Anthomegilla* and some *Rhinomegilla* may be mimics of bumble bees, as is *Melea,* since the orange-yellow pubescence is strikingly similar to that of sympatric bumble bees. The adults are active from June to July.

Included Species. A. (Anthomegilla) arctica Morawitz, *auripes* Morawitz, *beijingensis* (Wu), *carinulata* Morawitz, *crysocnemis* Morawitz, *latigena* Morawitz, *metallica* Morawitz and *wuae* Brooks. This subgenus occurs from central Asia to China. *A. arctica* occurs in the forest zone of Siberia and at high elevations [9000 feet (2743 m) or higher], in the mountains of Soviet Central Asia (Gurvich, 1931), in Mongolia, and in Xizang Province (Tibet), China (Wu, 1982).

Rhinomegilla new subgenus

Type species: *Anthophora megarrhina* Cockerell, 1910.

Diagnosis. Malar space a little longer than wide; mouthparts extremely long, galea in repose surpassing hind coxa, length of glossa 14-15 mm; flabellum broom-shaped, apically with numerous short lobes (Fig. 26b); genital capsule with a projection mesad and a membranous area laterad of ventral lobe of gonocoxite (Fig. 26h), penis valve elongate and narrow (Fig. 26g), bridge of penis valves basally acute, prolonged as narrow projection (Fig. 26h); hind tibia of female with posterior longitudinal margin having simple hair as in Figures 10d, e.

Description. a. Flagellar segment 1 of female about equal to length of next four segments together, of male about equal to next 3 segments. b. Face of male with yellow, of female black, mandible black; clypeus of male in profile projecting 1.7 width of eye; galea long (11-12 mm), in repose surpassing hind coxa, glossa 14-15 mm in length. c. Malar space a little longer than wide (Fig. 26c); flabellum apically with numerous short lobes (Fig. 26b); mentum without anterior tooth near basal third, about .9 as long as prementum; paraglossa about .5 as long as stipes. d-f. Midleg with brushes of male absent. g. Hind basitarsis of male simple; hind tibia of female with posterior longitudinal margin having simple hair as in Figures 10d, e. h. Basitibial plate of male absent. i. S6 of male apically entire, apical margin flexed ventrad (Fig. 26a). j. S7 of male apically entire; apicolateral margin with two weak lobes, a ventral lobe and slightly basal to it a dorsal lobe; apodeme long; slightly longer than length of disc (Fig. 26d). k. S8 of male apically narrowed, bilobed, lateral margin weakly angulate, almost straight; longitudinal sclerotization absent (Fig. 26e). l. Apex of gonocoxite of male simple, with weak ventral projection; with a projection mesad and a membranous area laterad of ventral lobe of gonocoxite (Figs. 26g, h). m. Gonostylus of male 8 times as long as wide. n. Apex of penis valve elongate and apically narrowed (Fig. 26g), about 3.7 times as long as wide as viewed apicodorsally. o. Bridge of penis valves basally prolonged as a sharp point, about twice as

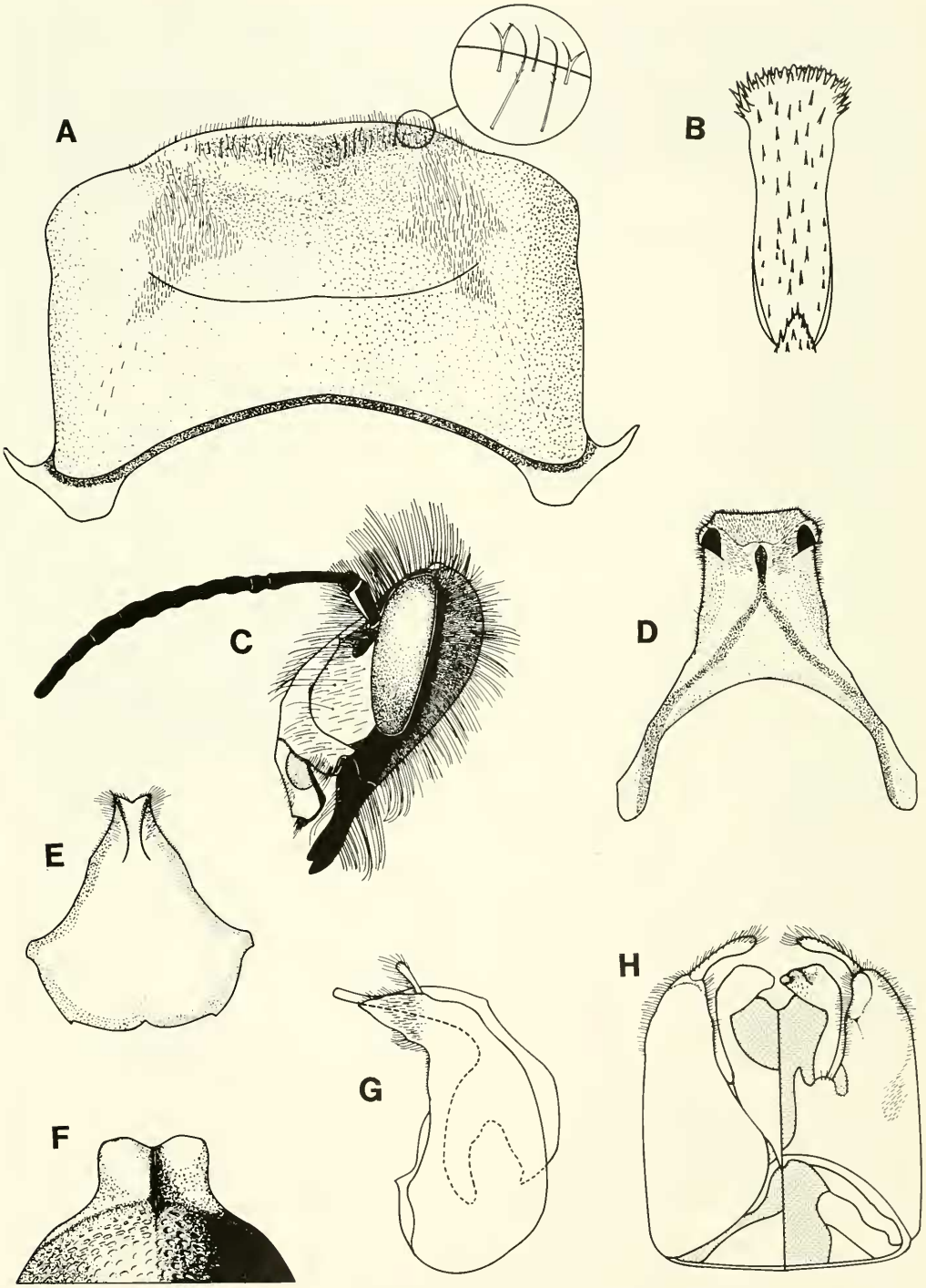


FIG. 26. *Anthophora (Rhinomegilla) megarrhina,* male. A, S6, ventral view. B, Flabellum, anterior view. C, Head, side view. D, E, S7 and S8, ventral views. F, Apex of T7 (hair omitted), dorsal view. G, H, Genital capsule, side and dorsoventral views.

long as wide (Fig. 26h). p. Apex of T7 of male medially with a shelf-like, emarginate process, longitudinally divided by a median carina from apex to slightly past base of process (Fig. 26f); gradular process of T7 of male absent (Fig. 26f). q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose slightly surpassing apex of gonostylus, about 1.8 times as long as gonostylus. s. Female length 8-20 mm, male length 8-19 mm.

Etymology. Rhinos (Gr.), nose, a prefix referring to the protuberant face, plus *Megilla,* a name of a related taxon.

Comments. Rhinomegilla is closely related to *Anthomegilla* but can be separated from that subgenus by the form of the flabellum and in the males by the additional characters of T7 (with an apicomedian shelf-like process), by the elongate narrowed penis valves and by the short apodemes and spiculum of S8 which is apically narrowed. Although *A. megarrhina* is almost completely black, some specimens have pale hair interspersed with black on the propodeum, metasomal sterna and T4 and 5; also the face and anterior half of the scutum sometimes have brownish-black hair.

Biology. Rhinomegilla flies in June and July.

Included Species. A. (Rhinomegilla) megarrhina Cockerell, *orophila* Cockerell, *sichuanensis* (Wu) and *spinitarsis* Wu. *Rhinomegilla* has only been collected in the Xizang and Sichuan Provinces of China and in Sikkim. *A. megarrhina* is found in Sikkim at Khamba Jong and Gantok at altitudes of 15-16,000 feet (4572-4877 m), in Gyangtse at 13,000 feet (3962 m) and Tinki Dzong at 14,000 feet (4267 m).

Petalosternon new subgenus

Type species: *A. rivolleti* Pérez, 1895.

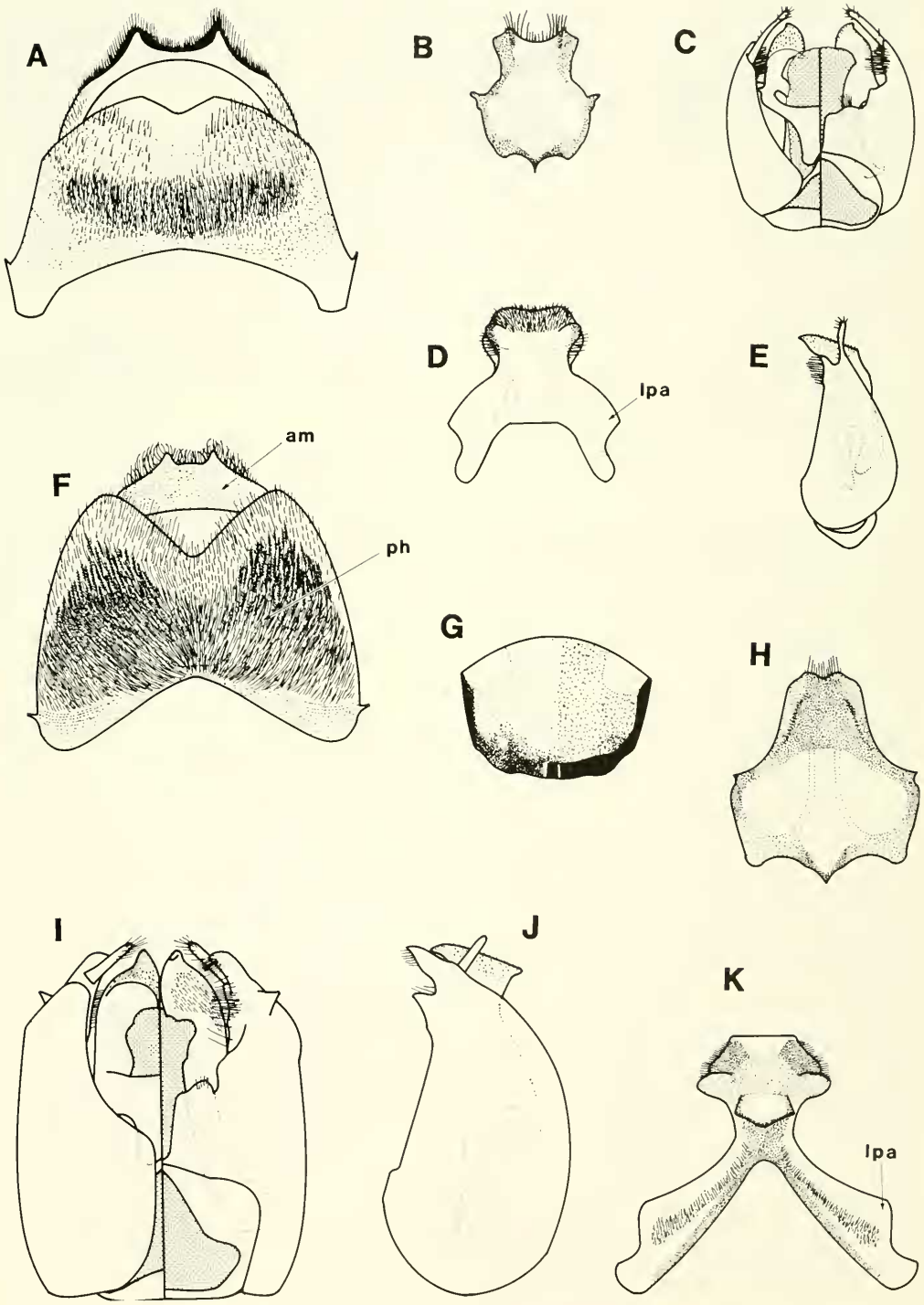
Diagnosis. Apodeme of S7 of male with lateral process (Fig. 27d); S8 of male broadly emarginate apically, apicolaterally angulate (Fig. 27b); labrum of male usually apically trilobed (Fig. 27g); pygidial plate of male absent, T7 with two submedian teeth (Fig. 27a); apex of gonocoxite of male diagnostic, in profile bilobed (Figs. 27e).

Description. a. Flagellar segment 1 of female equal to length of next 2.5-4.3 segments together; of male to next 1.7-2.7 segments. b. Face of male with yellow (except *A. albifascies* with white), of female black; labrum of male apically trilobed with emarginate median lobe (only emarginate median lobe present in *albifascies* and *orotavae;* lateral lobes weakly developed in *crassipes*) (Fig. 27g). c. Malar space of female 3.0-6.3 times as wide as long, of male 3.5-13.0 times as wide as long; flabellum apically with several finger-like lobes; mentum near basal third simple, without anterior tooth; mentum .7-.8 as long as prementum; paraglossa .7-.8 as long as stipes. d-f. Midleg brushes of male absent. g. Hind basitarsus of male simple (except *albifascies* and *hanseni* with sharp tooth); hind tibia of male normal or dilated with an anterior apical spine, tibial spur inserted on spine's apical third; hind femur of male normal or dilated, bulbous. h. Basitibial plate of male absent. i. S6 of male moderately to broadly emarginate (Fig. 27a). j. Apex of disc of S7 of male broadly, but weakly emarginate to entire (produced medially in *aeneiventris*), lateral margin medially with a weak ventral and dorsal lobe, sometimes dorsal lobe basal to ventral lobe; middle of disc simple, with one or two projections or with a longitudinal ridge; length of apodeme 1.0-1.6 times as long as length of disc (Fig. 27d). k. Apex of S8 of male weakly to deeply bilobed (produced medially in *aeneiventris*), lateral margin angulate to weakly concave; longitudinal sclerotization usually absent (Fig. 27b). l. Apex of gonocoxite of male in profile weakly bilobed ventroapically, sometimes with a tooth basal to lower lobe on inner margin of gonocoxite (Fig. 27e). m. Gonostylus of male flattened to round in cross section, 5.7- 11.0 times as long as wide, sometimes with expanded base. n. Apex of penis valve 1.4-2.7 times as long as wide viewed apicodorsally. o. Bridge of penis valve basally emarginate (entire in *hanseni* and *albifascies*), 1.9-3.1 times as long as wide (except *rivolleti* which is about as long as wide), bridge sometimes basally narrowed or expanded. p. Pygidial plate of male absent; apex of T7 of male with two submedian teeth (Fig. 27a) (no teeth, only shelf present in *hanseni*), much like *ireos* and other species of *Paramegilla,* sometimes with median, subapical longitudinal ridge; gradular process of T7 of male absent. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose slightly surpassing apex of gonostylus, about 2.3 times length of gonostylus. s. Length 10.0-12.5 mm.

Etymology. Petalos (Gr.), broad, flat, outspread, plus *sternon* (Gr.), referring to the wide disc of S7 of the male.

Comments. Petalosternon is closely related to *Dasymegilla* and *Clisodon.* It can be separated from *Clisodon* by the bidentate rather than tridentate mandibles, and from *Dasymegilla* males by having the part of the apical margin of T7 that is bent anteroventrad narrowed, and the much broader

FIG. 27. *Anthophora* subgenera *Petalosternon* and *Dasymegilla,* males. lpa = lateral process of apodeme, am = apex of T7, ph = felt-like pad of hair. A-E, G, *A. (P.) rivoletti* and F, H-K, *A. (D.) quadrimaculata.* A, S6, T7, ventral views. B, S8, ventral view. C, Genital capsule, dorsoventral view. D, S7, ventral view. E, Side view of genital capsule. F, S6, ventral view. G, Labrum. H, S8, ventral view. I, J, Genital capsule, dorsoventral and side views. K, S7, ventral view.


A
B
C
D
lpa
E
F
am
ph
G
H
I
J
K
lpa

S8 which is not nearly as narrowed medially. I know from no good characters to separate the females from *Dasymegilla.*

Biology. Adults are active from April to September.

Included Species. A. (Petalosternon) aeneiventris Hedicke, *albicilla* Pérez, *albifascies* Alfken, *calcarata* Lepeletier, *crassipes* Lepeletier, *cunicularia* Friese, *extricata* Priesner, *hanseni* Morawitz, *intricata* Gribodo, *moricei* Friese, *murina* Fedtschenko, *nigrociliata* Pérez, *orotavae* (Saunders), *priesneri* Alfken, *radoszkowskyi* Fedtschenko, *rivolleti* Pérez, *rugosa* Radoszkowszky, *similis* Fedtschenko, *wadicola* Alfken, *wegelini* Friese, and *zanoni* Gribodo. The distribution of this group is mainly Mediterranean and eastward to southwestern Mongolia.

Dasymegilla new subgenus

Type species: *Apis quadrimaculata* Panzer 1798 (=*Apis vulpina* Panzer 1798, nec Christ 1791).

Lasius Jurine, [1801-1802], p. 164. Invalidated by the suppression of the "Erlangen List" by the ICZN, Opinion 135.

Type species: *Apis quadrimaculata* Panzer 1798. Monotypic.

Diagnosis. S7 of male with long, widely separated apodemes and small disc (Fig. 27k); apex of gonocoxite of male bilobed (Figs. 27i, j); S6 with dense pad of hair on basal half (Fig. 27f); pygidial plate absent, T7 of male apically with two submedian teeth, actual apical margin bent anteroventrad, wide (Fig. 27f).

Description. a. Flagellar segment 1 of female about equal to length of next three segments together; of male to next 2.0-2.5 segments. b. Face of male creamy white to yellow, of female black; labrum of male apically trilobed as in *Petalosternon* (Fig. 27g) (weakly so in *A. lacteifrons,* simple in *muscaria, excisa* and *waltoni*), with emarginate median lobe. c. Malar space of female 4-5 times as wide as long, of male 5-7 times as wide as long; flabellum apically with several finger-like lobes; mentum near basal third simple, without anterior tooth (except *excisa*), mentum about .6 as long as prementum; paraglossa about half as long as stipes. d-f. Midleg brushes of male absent. g. Hind basitarsus of male simple. h. Basitibial plate of male absent (present in *excisa*). i. S6 of male with apical margin weakly to narrowly emarginate with thick, dense pad of hair occupying basal half of disc (Fig. 27f). j. Apex of disc of S7 of male entire to weakly emarginate, apicolateral margin with two lobes, a dark sclerotized ventral lobe and light sclerotized dorsal lobe, middle of disc with dark sclerotized transverse ridge or protuberance, length of apodeme 1.00-1.75 times as long as length of disc (Fig. 27k). k. Apex of S8 of male weakly bilobed, lateral margin on apical half concave, longitudinal sclerotization present (Fig. 27h). l. Apex of gonocoxite of male in profile bilobed (Fig. 27j). m. Gonostylus of male 6 times as long as wide (Fig. 27i). n. Apex of penis valve about twice as long as wide with scattered setae. o. Bridge of penis valve basally emarginate, 2.0-2.5 times as long as wide. p. Pygidial plate of male absent; apex of T7 of male with two acute, short, submedian teeth, actual apical margin bent anteroventrad and wide (Fig. 27f); gradular process of T7 of male absent. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose attaining apex of gonostylus, about 2.3 times length of gonostylus. s. Length of male, 9.0- 11.0 mm, female, 10.0-12.5 mm.

Etymology. Dasys (Gr.), densely hairy, plus *Megilla* a name of a related taxon, referring to the large, dense patch of hair on the basal half of S6 of the male.

Biology. The only species of *Dasymegilla* whose nesting biology is known is *A. quadrimaculata* (Nielsen, 1902).

Included Species. A. (Dasymegilla) excisa Morawitz, *lacteifrons* Hedicke, *muscaria* Fedtschenko, *quadrimaculata* (Panzer), *siewersi* Morawitz and *waltoni* Cockerell. They are found throughout Europe including England, Scandinavia, the Mediterranean region and eastward to central and southern China.

Subgenus *Clisodon* Patton

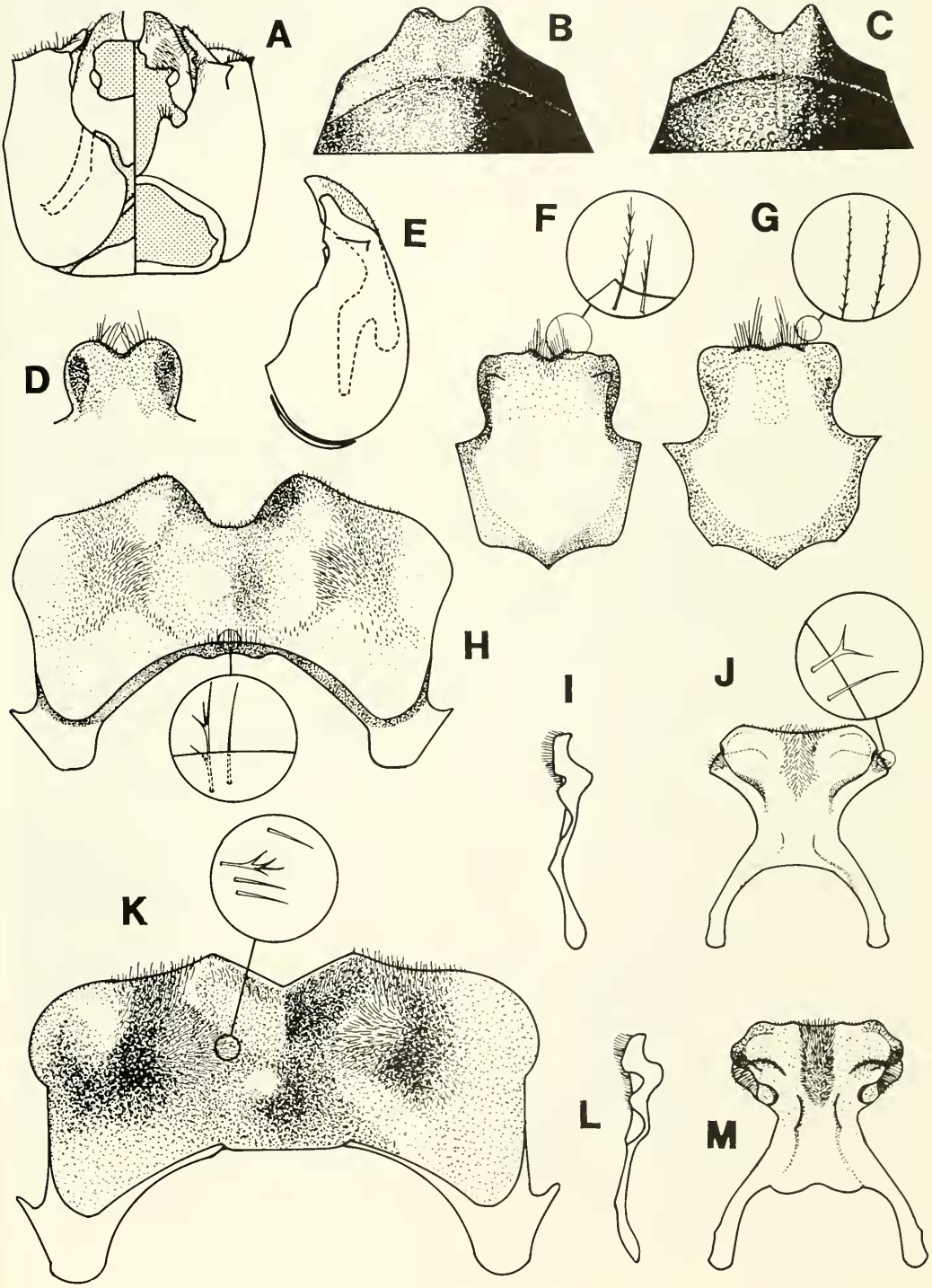
Clisodon Patton, 1879, p. 149.

Type Species: *Anthophora terminalis* Cresson, 1869. Original designation.

Diagnosis. Mandible tridentate; gonostylus of male, if present, completely sclerotized, concolorous with gonocoxite (see *Description,* character n); female with basitibial plate elongate and pointed (Fig. 29b); flabellum apically entire (Figs. 29c, d); female with hairs of posterior margin on hind tibia simple as in Figure 10e, penis valve with thick, round, patch of hair ventrally (Fig. 28a).

Description. a. Flagellar segment 1 of female equal to next 3.0 segments together, of male equal to next 2.3 segments. b. Face of male with yellow markings, of female black; mandible tridentate. c. Malar space of female about 7 times as wide as long, of male about 5.5 times as wide as long; flabellum apically entire (Figs. 29c, d); mentum

FIG. 28. *Anthophora* subgenus *Clisodon,* males. A, C, E, F, H-J, *A. (C.) furcata;* B, G, K-M, *A. (C.) terminalis.* A, Genital capsule, dorsoventral view. B, C, Apex of T7 (hair omitted), dorsal views. D, Apex of S8, ventral view, *A. (C.)* sp. from Bohemia. E, Genital capsule, side view. F, S8, ventral view, specimen from Celákovic, Czecholavakia. G, H, S8 and S6, ventral views. I, J, S7, side and ventral views. K, S6, ventral view. L, M, S7, side and ventral views.


A
B
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.7 as long as prementum, mentum simple, without anterior tooth near basal third; paraglossa .7 as long as stipes. d-f. Midleg brushes of male absent. g. Hind basitarsus of male simple, flattened and curved posteriad; hind tibia of female with scopal hairs simple, lacking posterior band of plumose hairs (Figure 10e). h. Basitibial plate of male absent, of female elongate, apically pointed (Fig. 29b). i. S6 of male apicomedially emarginate, apical margin flexed ventrally, disc on anterior half with large bump on either side of a smaller, slightly more basal, median one (Figs. 28h, m). j. Disc of S7 of male broad, apex broadly but shallowly emarginate, apicolateral margin of disc with a ventral lobe and slightly basal to it a dorsal lobe, disc with lateral, basal projection and with longitudinal median band of hair (Figs. 28k-m, o), apodeme .6-.8 times as long as disc (Fig. 28l). k. S8 of male apically broad, apicolateral margin rounded to angulate, longitudinal sclerotization absent (Figs. 28i, j). l. Apex of gonocoxite of male trilobed *(A. furcata)* to bilobed *(terminalis)* in profile, with large, apical, inner lobe and two *(furcata)* or one *(terminalis)* smaller laterobasal, outer lobe (Fig. 28e). m. Gonostylus of male, if present, concolorous with apex of gonocoxite such that there is no demarcation between the two (Fig. 28a). n. Apex of penis valve 1.6 times as long as wide, covered with short hair and ventrally with a round patch of longer hair (Fig. 28a). o. Bridge of penis valve basally emarginate, 2.4 times as long as wide. p. Pygidium of male apically with 2 submedian teeth, dorsoventrally flattened, gradular process of T7 of male developed, (Figs. 28b, c). q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose attaining apex of gonostylus, about 2.2 times as long as gonostylus. s. Length 9-13 mm.

Comments. Marikovskaya (1979), using the taxonomic analysis method of Smirnov (1969), broadened the definition of *Clisodon* and added 17 species. She recognized two groups, the first (*C.*

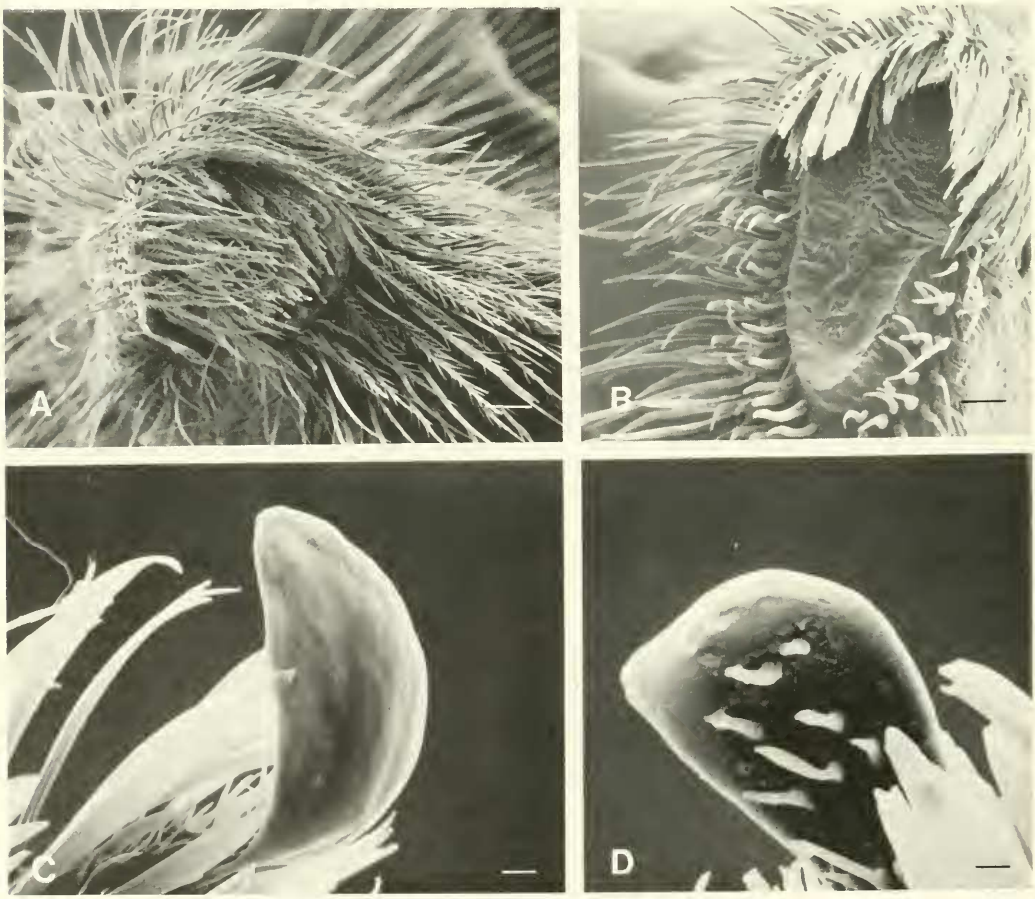


FIG. 29. *Anthophora* subgenera *Pyganthophora* and *Clisodon.* Scale lines represent .1 mm in A, B, and .01 mm in C, D. A, B, Basitibial plates of *Anthophora (Pyganthophora) edwardsii* male and *A. (Clisodon) terminalis,* female. C, D, Flabella of *A. (Clisodon) terminalis* lateroposterior and anterior views.

furcatus group) including *A. furcata* (Panzer), *terminalis* Cresson, *borealis* Morawitz, *meridionalis* Fedtschenko, *raddei* Morawitz, *pubescens* (Fabricius), *dufourii* Lepeletier, *wegelini* Friese, *rivolleti* Pérez and *urbana* Cresson and the second (*A. parietina* group) consisting of *plagiata* (Illiger) [=-*parietina* (Fabricius)], *nigripes* Morawitz, *orientalis* Morawitz, *siewersii* Morawitz, *excisa* Morawitz, *vulpina* (Panzer), *muscaria* Fedtschenko, *hortensis* Morawitz, and *gracilipes* Morawitz. Marikovskaya's broad definition and diagnosis of *Clisodon* and of her two included groups is based on characters showing much variation. In my opinion *Clisodon* (sensu Marikovskaya) is polyphyletic and represents seven distinct lineages which I place in other subgenera of *Anthophora*.

Clisodon (in its usual restricted sense) has often been accorded generic rank (Patton, 1879; Popov, 1951). Its mandibular and basitibial plate differences from other *Anthophora* are striking, no doubt associated with its wood-nesting habits. It is, however, only a small derived group of *Anthophora;* the derived features are neither so numerous or so striking as to justify generic rank (and the resulting paraphyly of *Anthophora).*

Biology. The adults are active from mid May to September. Many of the uniquely derived characters of *Clisodon,* which easily separate it from its close relatives *Dasymegilla* and *Petalosternon,* such as the tridentate mandibles and basitibial plate of the female, are presumably adaptations to wood nesting. Wood as a nesting substrate is known only for *Clisodon* in the Anthophorini [except perhaps for *A. (Anthophoroides) signata*]. Females nest in fallen logs utilizing beetle exit holes, and in rotten wood, stumps, telephone poles, fence posts, partially decayed or pithy sticks, etc. [(W. P. Cockerell, 1903, and Medler, 1964 — *terminalis*); (Nielsen, 1902; Popov, 1951; Radchenko, 1984 — *furcata*)]. Because of the preferance for a wood substrate, *Clisodon* is usually a forest dweller. I have observed the dark form (*pernigra* Cresson of *terminalis*) nesting in driftwood among sand dunes on Mad River Beach in Humboldt County, California. The females, which are somewhat polylectic, have a definite preference for plants of the family Lamiaceae, especially *Stachys* (Popov, 1951).

Included Species. A. (Clisodon) furcata (Panzer), *sinensis* (Wu), *terminalis* Cresson and *xinjiangensis* (Wu). *Clisodon* is a boreal holarctic group which ranges far into the Arctic both in North America and the U.S.S.R. Popov (1951) found that the distribution of *terminalis* besides being nearctic, included East to Central Asia and that of *furcata* was mainly European to the Near and Middle East. In the United States *terminalis* is generally found wherever there are northern woodlands, i.e., in the northern states and in the mountains southward.

Subgenus *Heliophila* Klug

Heliophila Klug, 1807, p. 227.
Type species: *Apis bimaculata* Panzer, 1798. Monobasic.

Saropoda Latreille, 1809, p. 177.
Type species: *Apis bimaculata* Panzer, 1798. Autobasic. Proposed unnecessarily for *Heliophila* Klug, 1807, not *Heliophilus* Meigen, 1803.

Micranthophora Cockerell, 1906, p. 66. **New Synonym.**
Type species: *Anthophora curta* Provancher, 1895 (=*A. squammulosa* Dours, 1869). Original designation.

Diagnosis. Length 6.0-15.0 mm, usually 10 mm or less in almost all species of Humilis and Estebana species groups; female face with pale markings, rarely all black as in *A. praecox;* posterior margin of female hind tibia with simple hair (Fig. 10d); male of Old World species usually with S6 and often S5 with thick pad of hair in a depression (Figs. 30a, 31e), pad covering much of preapical ventral surface.

Description. a. Flagellar segment 1 of female equal to length of next 2.0-3.5 segments together; of male equal to next 1.1-2.8 segments. b. Face with white to yellow markings, rarely black; male with paraocular and supraclypeal marks present or absent, labrum of male usually apically trilobed with median lobe emarginate (as in Fig. 30l); scape of male with pale marks anteriorly; female clypeus usually bearing inverted T-shaped mark, paraocular marks of female present or absent, supraclypeal mark of female present or absent; maxillary palpus 4-6 segmented; labial palpus 2 or 4 segmented (apical 2 segments sometimes lost). c. Malar space of female 5-16 times as wide as long, of male 6-16 times as wide as long; flabellum apically with several finger-like lobes; mentum without anterior tooth on basal third, mentum .6-.7 as long as prementum (except .3 in *A. hololeuca*); paraglossa about .50-.75 as long as stipes. d-e. Midtarsal and midbasitarsal brushes of male absent. f. Middistitarsal brush of male sometimes present. g. Hind basitarsus of male simple (except *flexipes* with anterior tooth), sometimes flattened and/or strongly curved; hind tibia of male sometimes with apical, anterior spine; posterior margin of hind tibia of female with simple hair (Fig. 10d). h. Basitibial plate of male usually present. i. S6 of male usually apicomedially emarginate (Fig. 30a), in Old World species usually with dense pad of hair covering much of basal half of ventral surface, basally delimited by gradulus (Figs. 10f, 30a), pad occupying large, flat depression; in Old World species S5 often with similar pad of hair and depression, often deeply emarginate apically. j. S7 of male (Fig. 30e) not or slightly expanded apically, emarginate to produced medially with apex gently rounded; lateral margin with two

lobes to simple; length of apodeme .28-.75 length of disc [except 1.16 length of disc (Fig. 30e) in *bimaculata*]. k. S8 of male apically emarginate, occasionally emargination weak to absent; apicolateral margins either angulate or rounded, longitudinal sclerotization present to absent (Fig. 30d). l. Apex of gonocoxite of male flattened, in side view usually bilobed to trilobed (Fig. 30c), occasionally simple. m. Gonostylus of male short, from dorsal view flattened, 2.2-8.5 as long as wide. n. Apex of penis valve 1.3-3.0 as long as wide viewed apicodorsally. o. Bridge of penis valves usually not basally expanded, 1.0-2.5 as long as wide and basally entire to emarginate. p. T7 of male with two apical teeth (pygidial plate in *fraterna* and *squammulosa*), additionally two or more subapical teeth occasionally present in Ethiopian species; gradular process of T7 of male usually well developed, sometimes prolonged into tooth (Fig. 30f); female pygidial plate with or without median ridge. First recurrent vein joining submarginal cell 2 distal to midpoint. q. First

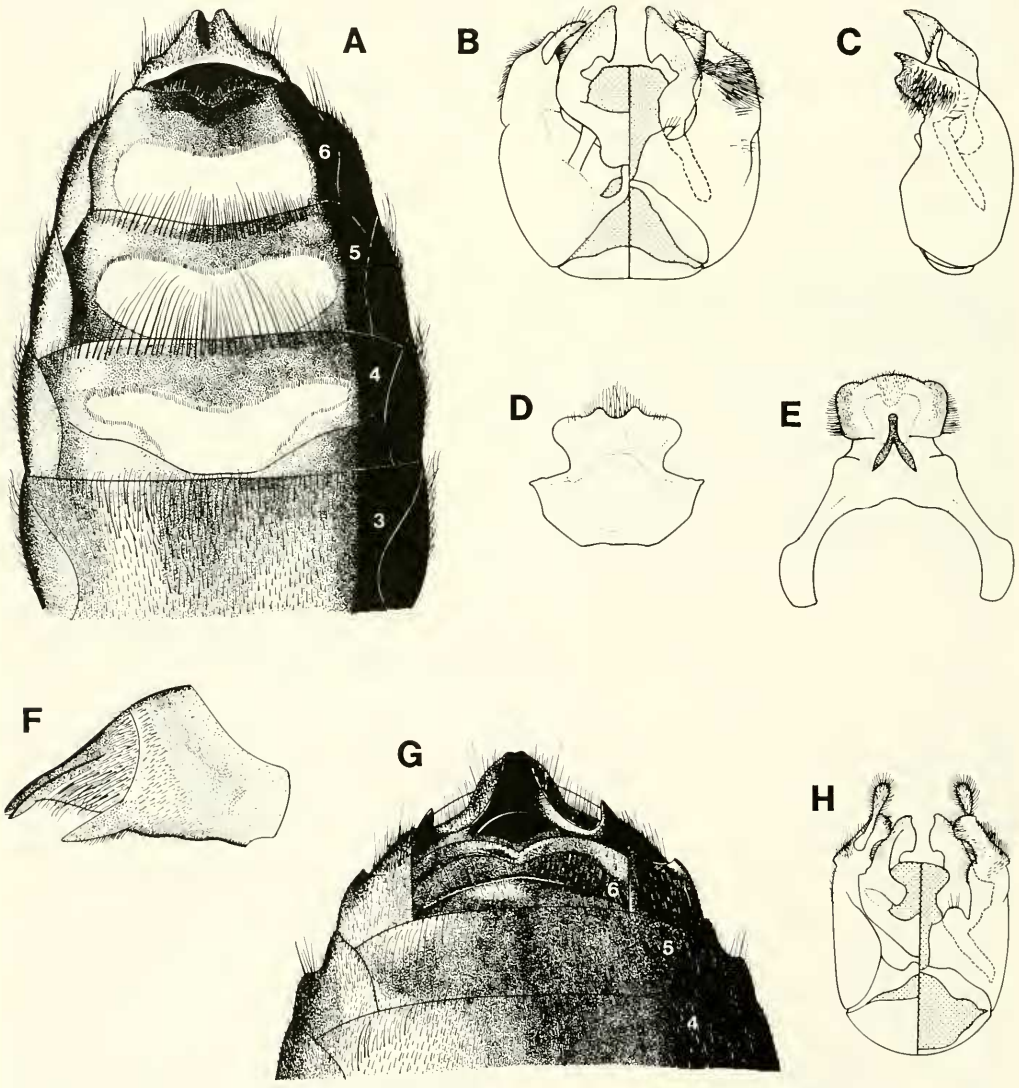


FIG. 30. *Anthophora* subgenus *Heliophila,* males of Humilis and Estebana species groups. Numbers are the numbers of the metasomal sterna. A-E, *A. (H.) bimaculata;* F-L, *A. (H.) squammulosa.* A, S3-S6, T7, ventral views. B, C, Genital capsule, dorsoventral and side views. D, E, S8 and S7, ventral views. F, T7, side view. G, S4-S6, T7, ventral views. H, I, Genital capsule, dorsoventral and side views. J, K, S7 and S8, ventral views. L, Labrum.

recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose attaining to surpassing apex of gonostylus, about 2.2-2.7 times as long as gonostylus. s. Length 6.0-15.0 mm.

Comments. An attractive idea is to separate *Heliophila* as a genus from *Anthophora*. I long considered this possibility, which could be justified on the basis of small size and somewhat dissimilar male terminalia. However, the Vestita species group bridges the gap between the two so that recognition of *Heliophila* as a genus would be highly arbitrary as well as making *Anthophora* paraphyletic.

Humilis Species Group

Description. a. Flagellar segment 1 of female equal to length of next 2.0-3.0 segments together; of male equal to next 1.1-2.0 segments. b. Face with white to yellow markings; male with paraocular and supraclypeal marks present, labrum of male usually apically trilobed with median lobe emarginate (as in Fig. 30l); scape of male with pale marks anteriorly; female clypeus bearing inverted T-shaped mark, rarely all pale (ascending median arm of mark almost never absent or indistinct as in an undescribed species from Cape Province, South Africa), paraocular marks almost always absent (except in an undescribed species from Kenya and Tanzania), supraclypeal mark present; maxillary palpus 4-6 segmented; labial palpus 2 or 4 segmented (apical 2 segments sometimes lost). c. Malar space of female 5-13 times as wide as long, of male 6-16 times as wide as long; paraglossa about .5 as long as stipes. f. Middistitarsal brush of male sometimes present. g. Hind basitarsus of male simple, sometimes flattened and/or strongly curved; hind tibia of male sometimes with apical, anterior spine. h. Basitibial plate of male usually present. i. S6 of male usually apicomedially emarginate (Fig. 30a), but some southern and southeastern African species with apex entire (e.g., some *rufovestita* and *tetradonta*); usually with dense pad of hair covering much of basal half of ventral surface, basally delimited by gradulus (Figs. 10f, 30a), pad occupying large, flat depression (pad absent in some African species); S5 often with similar pad of hair and depression, often deeply emarginate apically. j. S7 of male (Fig. 30e) not or slightly expanded apically, entire medially (rarely emarginate and then only slightly) with apex gently rounded; lateral margin with two lobes, ventral more apical lobe larger and usually more darkly sclerotized than dorsal one; disc sometimes with lateral margins lobed midway (as in some African species) but usually margins gradually converging toward apex, length of apodeme .32-.61 length of disc [1.16 length of disc (Fig. 30e) in *bimaculata*]. k. S8 of male apically emarginate, occasionally emargination weak; apicolateral margins either angulate or rounded, longitudinal sclerotization usually present (Fig. 30d). l. Apex of gonocoxite of male flattened, in side view bilobed to trilobed (Fig. 30c), in ventral or dorsal views apicolateral margin either angulate or rounded, apex not projecting inward but extending somewhat straight distally (Fig. 30b). m. Gonostylus of male short, from dorsal view flattened, 3.0-6.0 as long as wide. n. Apex of penis valve 1.3-2.6 as long as wide viewed apicodorsally. o. Bridge of penis valves not basally expanded, either 1.0-1.5 as long as wide and basally entire, or bridge 2.0-2.5 times as long as wide and sometimes emarginate basally (Fig. 30b). p. Pygidial plate of male present, apically emarginate, sometimes like that of *Lophanthophora* (e.g., *fraterna*), or with a short tooth situated laterobasally on margin of pygidial plate (e.g., *rufovestita*), or deeply emarginate (Fig. 10f) (e.g., *fulvodimidiata*), more often with strong median ridge; gradular process of T7 of male usually well developed, sometimes prolonged into a tooth (Fig. 30f); female pygidial plate almost always flat, without median ridge [an undescribed species from Peshin Jan (Farah) India has a well developed ridge]. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose attaining apex of gonostylus, about 2.4 times as long as gonostylus. s. Length 7.5-11.5 mm.

Comments. A. bimaculata is typical of a small species group within the Humilis group, not formally recognized here, having distinctly different terminal sterna. The S7 of male *bimaculata* has long apodemes and S8 is narrower apically and more deeply emarginate than subsaharan species (Figs. 30d, e). The rest of the species of the Humilis group (mainly African) have S7 with short apodemes and S8 apically broad with lateral margins weakly emarginate.

The Humilis species group is a group with transitional characters between the Estebana (= *Micranthophora*) and the Vestita species groups, although it is most closely related to the latter from which it differs by its small size, more extensive pale markings on the faces of females, lack of the two median projections on the female labrum, apicolateral margins of the genital capsule more or less straight and S8 of the male with lateral margin deeply emarginate. The Humilis group is similar to the Estebana group, being differentiated usually by the synapomorphies (shared with the Vestita group) of the dense pads of hair on S6 and S5 in males, lateral margin of S7 of male weakly bilobed (ventral as well as dorsal lobe present), S8 of male with apicolateral margins produced (not with apex produced as in the Estebana group), longitudinal sclerotization of S8 usually present and pygidial plate of female usually flat (see character p).

Biology. The adults are active from March to November in the Palearctic region and November to August in subsaharan Africa.

Included Species. A. (Heliophila) albella Gussakovsky, *albifronella* Brooks, *albopicta* Cockerell, *alfkenella* Priesner, *appletoni* Cockerell, *bimaculata*

(Panzer), *candidifrons* Cockerell, *concinna* (Klug), *deceptrix* Priesner, *elbana* Priesner, *eugeniae* Gussakovsky, *fallaciosa* Priesner, *fayoumensis* Priesner, *ferripicta* Cockerell, *flavofimbriata* Hedicke, *fulvodimidiata* Dours, *fraterna* Bingham, *galalensis* Priesner, *gemella* Morawitz, *hegasica* Priesner, *humilis* (Spinola), *loewi* Fedtschenko, *longipes* Morawitz, *mellina* Priesner, *nigripes* Pérez, *perlustrata* Priesner, *pygmaea* Meade-Waldo, *richaensis* Alfken, *rufovestita* Cockerell, *saropodoides* (Dalla Torre), *selecta* Priesner, *shagrensis* Priesner, *soikai* Benoist, *tarsalis* Priesner, *tenella* (Klug), *tetradonta* Cockerell, *tibialis* Morawitz, *tridentata* (Friese), *tridentella* Priesner, *trilineata* (Pérez), and *xanthostoma* Cockerell. This group is found in the savanna regions of Africa but reaches the Mediterranean region and southern Europe, thence eastward to Xizang Province (Tibet), China.

Vestita Species Group

Description. a. Flagellar segment 1 of female equal to length of next 2.7-3.3 segments together; of male equal to next 1.3-2.8 segments. b. Face with white to yellow markings, rarely all black; female usually with pale transverse mark across apex of clypeus, rarely in form of inverted T (*A. oldi* and *micheneri* have an inverted T-shaped mark), rarely all black (e.g., *praecox*); paraocular and supraclypeal marks in female usually absent, in male usually present (except species with all black faces e.g., *praecox*); maxillary palpus usually with 6 segments, sometimes 5; labrum of female almost always with two median projections, their widths .2-.5 labral width, one situated midway, the other apical; apical projection of female labrum bilobed, middle projection of female labrum often shelf-like, apically entire to bilobed (Fig. 32a) (projections reduced in *praecox,* absent in *micheneri*); labrum of male apically trilobed (except *pulverosa,* medioapically bilobed) with median lobe emarginate, projection in middle of labrum as in female when present, but usually absent; scape of male with pale marks anteriorly (except those with all black faces). c. Malar space of female 6-13 times as wide as long, of male 8-12 times; paraglossa .50-.75 length of stipes. f. Middistitarsal brush of male usually present. g. Hind basitarsus of male simple. h. Basitibial plate of male usually present (absent in *vestita* and *pulverosa*). i. S6 of male entire to shallowly emarginate apically, basal half to two-thirds of disc with dense pad of hair as in males of Humilis group (Fig. 32b) (absent in *pulverosa*); S5 of male with similar pad of hair, apically emarginate (*pulverosa* without pad of hair and apically entire); S4 of male occasionally with similar pad of hair, pads of hair on metasomal sterna 6-5 (and 4 when pad present) each recessed into a depression. j. S7 of male as in males of Humilis group except dorsal pair of apicolateral lobes sometimes absent, length of apodeme .28-.43 length of disc (Fig. 32e). k. S8 of male mediobasally blunt, rounded, apically broad, apicolateral margin angulate, longitudinal sclerotization present (Fig. 32f). l. Apex of gonocoxite of male strongly produced laterally as viewed from beneath, inner margin somewhat straight (Fig. 32c). m. Gonostylus of male 3.7-6.3 times as long as wide, flattened (Fig. 32c). n. Apex of penis valve 1.5-2.7 times as long as wide viewed apicodorsally. o. Bridge of penis valves basally emarginate, sometimes expanded basally, length 1.6-2.5 times as long as wide. p. T7 of male dorsally deeply concave, forming round pit with 2 submedian teeth extending from apical shelf or more deeply emarginate without shelf-like area and dorsal concavity; median longitudinal ridge of T7 absent; gradular process of T7 developed, sometimes prolonged into a spine; pygidial plate of female flat. q. Venation like that of Humilis group. r. Sting in repose surpassing apex of gonostylus as much as .4 length of gonostylus; sting 2.4-2.7 as long as gonostylus. s. Length 10-15 mm.

Comments. Some species have males with all black faces, a character which is not found in the Humilis and Estebana groups, but is found occasionally among other species of *Anthophora.* The moderate size of the bees and the relatively limited pale marks of the female face are characters of the Vestita group shared with other subgenera of *Anthophora* and not with the Humilis group. The Vestita group has more plesiomorphies than the Humilis and Estebana groups.

Biology. The adults fly from October to August. Rozen (1969) gave some biological notes on *A. braunsiana* and *rufolanata* (determined as *krebsi*) which were attacked by the cuckoo bees *Thyreus* and *Coelioxys* respectively.

Included Species. A. (Heliophila) argyrospila Cockerell, *braunsiana* Friese, *ekuivensis* Cockerell, *elimata* Cockerell, *eritrea* Brooks, *joetta* n. sp., *kigomensis* Cockerell, *kigoserana* Friese, *kodrokonis* Cockerell, *kristenseni* Friese, *labrosa* Friese, *lumbwana* Cockerell, *matopensis* Cockerell, *micheneri* n. sp., *oldi* Meade-Waldo, *perdita* Cockerell, *praecox* Friese, *pulverosa* Smith, *rhodesiae* Meade-Waldo, *rufolanata* Dours, *tuberculilabris* Dours, *vestita* Smith, *wartmanni* Friese, and *zombana* Cockerell. The Vestita group is confined to subsaharan Africa and has its greatest species diversity from Kenya to South Africa.

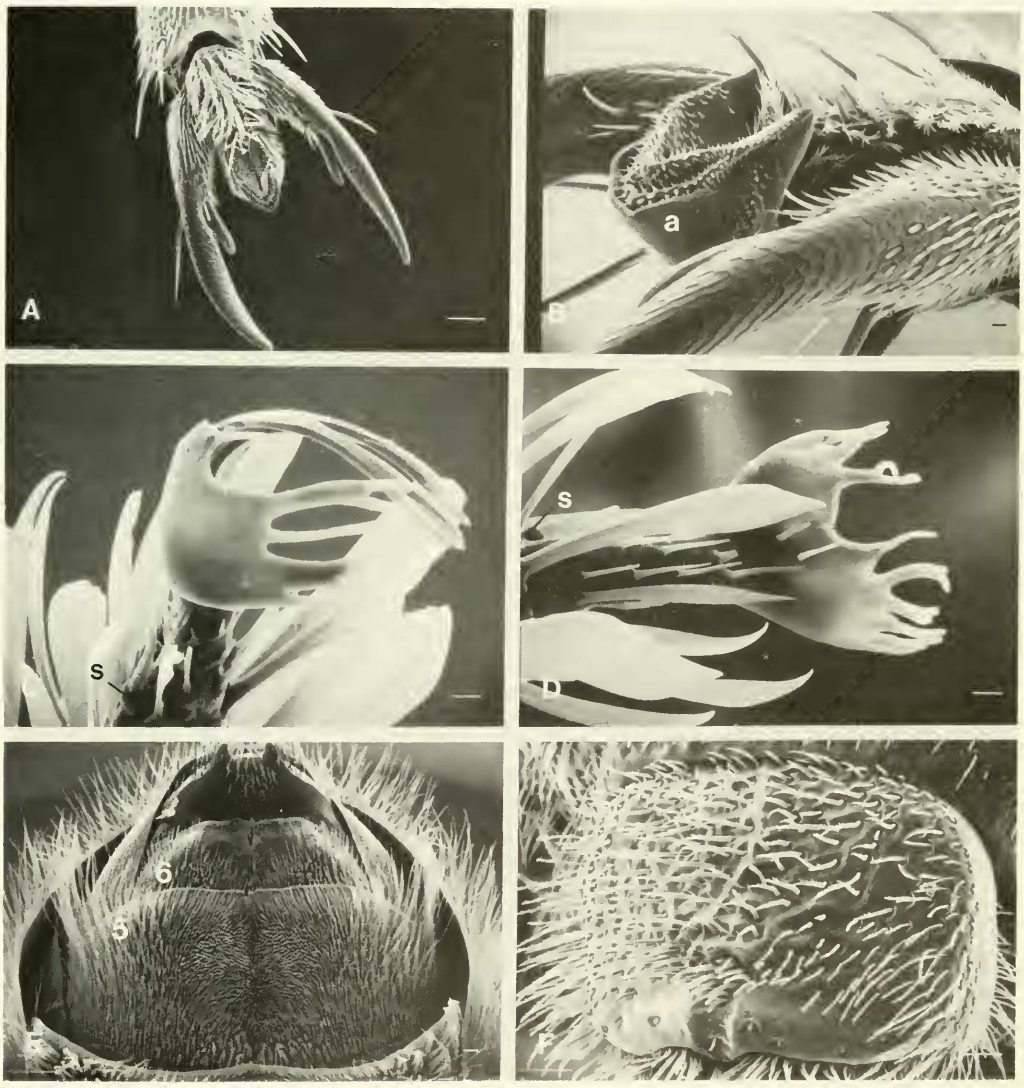


FIG. 31. *Anthophora (Heliophila) bimaculata.* Scale lines (on right side) represent .1 mm in A, E, F, .01 mm in B-D; a = arolium, s = seta. A, B, Hind tarsus of female. C, D, Lateroposterior and anterior views of flabellum. E, Ventral view of male metasoma showing the dense pad of hair on S5 and only the apex of the pad of hair on S6. F, Clypeus of male showing rugose-lacunose sculpturing and apicomedian emargination.

Estebana Species Group (=*Micranthophora*)

Description. a. Flagellar segment 1 of female equal to next 2.2-3.5 segments together, of male equal to next 1.0-2.5 segments. b. Face with white to yellow markings; mandible bidentate (simple in *A. phenax* male); paraocular marks of male usually absent (except in *cockerelli* and *phenax*), supraclypeal mark sometimes present, clypeus usually without inverted T-shaped mark (*flexipes* and *nigritula* with inverted T-shaped mark, *phenax* and *cockerelli* clypeus all pale) but with transverse mark across apex, labrum of male apically trilobed with median lobe emarginate (Fig. 30l) (except *columbariae* simple, weakly trilobed in *abroniae* and *phenax*), scape of male black or with pale marks anteriorly; female with paraocular marks usually absent (except *cockerelli* and *mortuaria*), supraclypeal marks usually present (except *squammulosa, estebana, phenax,* and *salazariae*), clypeus with a transverse mark across apex to a well developed inverted T-shaped mark (clypeus all pale in *cockerelli*); maxillary palpus almost always with 6 segments (*salazariae* with 5, *phenax* with 4). c. Malar space of female 5-16 times as wide as long, of male 6-15 times; paraglossa .50-.75 as long as stipes. g. Hind basitarsus of male simple (flattened, laterally expanded and with anterior tooth in *flexipes*). h. Basitibial plate of male present or absent. i. S6 of male emarginate apicomedially (Fig. 30g) (except *petrophila* entire, *flavocincta* entire with a pair of lateral depressions, *exigua* apicomedially produced), pad of dense hair absent. j. S7 of male apically expanded, emarginate to produced medially, with a lateral light sclerotized mark on each side, lateral margin without ventral and dorsal lobes, apodeme 0.30-.75 as long as disc (Fig. 30j). k. Apex of male S8 narrowly produced, often emarginate; lateral margin lobed midway or distad of middle,, usually strongly angulate (Fig. 30k), but in a few species weakly rounded, longitudinal sclerotization absent. l. Apex of gonocoxite of male flattened, in side view weakly bilobed to trilobed (Fig. 30i), projecting inward, apicolateral margins not produced, subparallel (Fig. 30h). m. Gonostylus of male 2.2- 8.5 times as long as wide (in *squammulosa* and *peritomae,* 10.0 times), usually flattened, seldom round in cross section. n. Apex of penis valve 2.2-3.0 times as long as wide viewed apicodorsally. o. Bridge of penis valves about as wide as long, entire and not enlarged basally. p. Pygidial plate of male absent (present only in *squammulosa,* similar to that of male *Lophanthophora*); longitudinal, median, narrowly carinate ridge absent (present in *abroniae, columbariae, mortuaria, pachyodonta, salazariae, squammulosa,* and one undescribed species); pygidial process of T7 of male present as two apical, submedian, dorsoventrally flattened projections (absent in *squammulosa*); gradular process of T7 of male often present (absent in *abroniae, columbariae, nigritula, phenax,* and *salazariae*), sometimes only weakly developed (as in *cockerelli, mortuaria,* and *pachyodonta*) or present as a tooth; pygidial plate of female with median, longitudinal ridge somewhat flattened to strongly carinate, sometimes lateral margins also carinate. q. Venation as in Humilis group. r. Sting in repose attaining apex of gonostylus, 2.2-2.4 times as long as gonostylus. s. Length 8-13.5 mm.

Comments. The Estebana Group is restricted to the New World and is closely related to the Old World Humilis group from which it is separated by the characters given in the *Comments* under the latter.

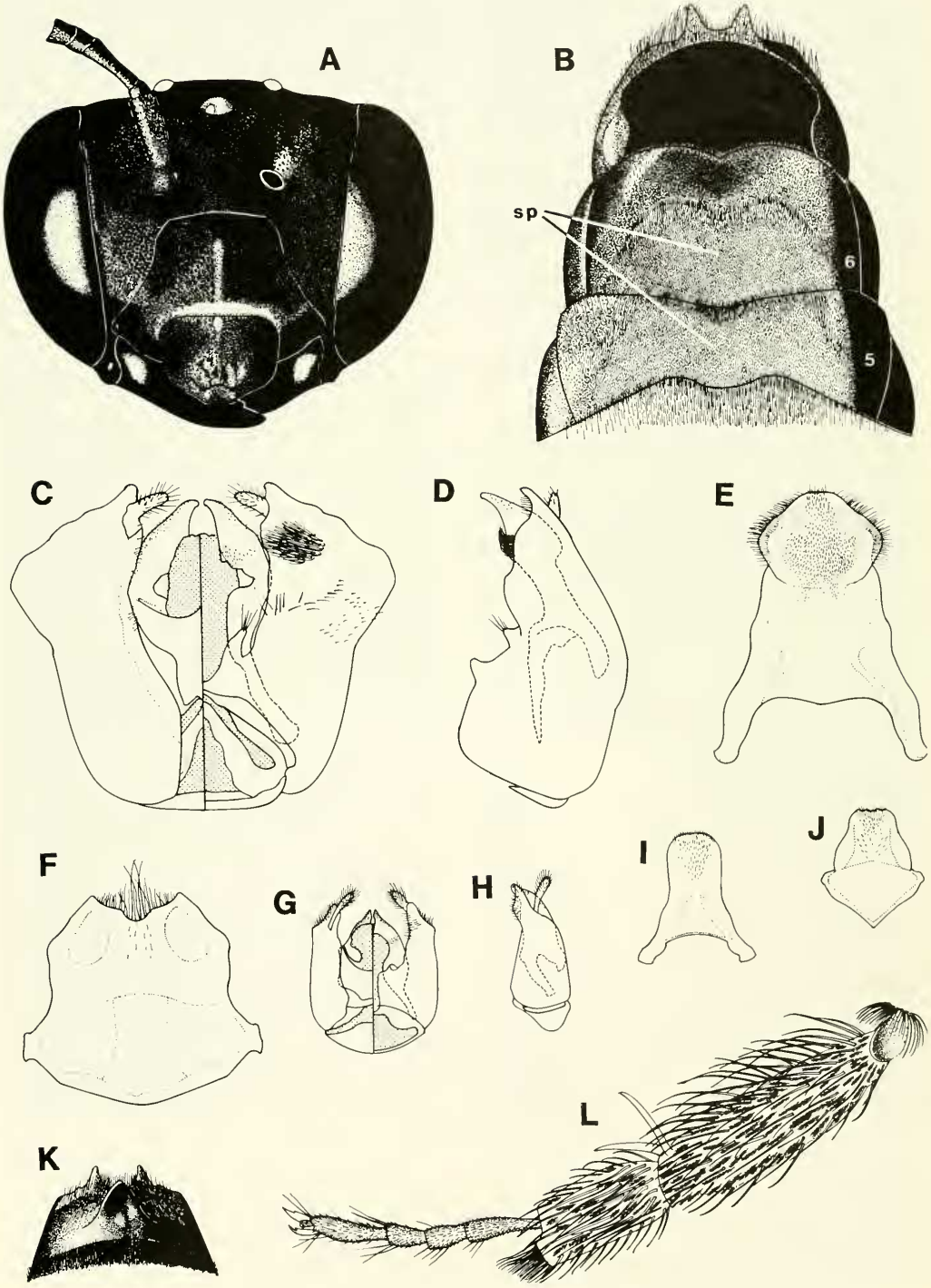
A. hololeuca, an unusual species, is found in California, Arizona and México (Baja California and Sonora) and is the smallest bee in the tribe Anthophorini. It differs from all other members of the Estebana group by the following characters: length 6-8 mm; scape of both sexes black and anteriorly with a thick patch of white hair similar in appearance to pale integumental markings; mentum .3 length of prementum; lorum V-shaped; labial palpus with two short segments (apical two lost); stipes and prementum with longitudinal rugae; hind tibia of female on outer surface with appressed white pubescence between long, simple scopal hairs (Fig. 32l). The short lorum and mentum, loss of two segments each from the maxillary and labial palpi, and rugose prementum and stipes may be adaptations to the types of host plants visited for nectar and pollen. Its short mouthparts are presumably adapted to small shallow flowers.

A. flexipes is an extremely derived species, unique in several male attributes, not the least being the elongate and oddly modified fore and midlegs and the gradular process on T6 which is prolonged into a tooth similar to that of T7.

Biology. Adults are active from February to November. The only biological accounts of species of the Estebana group is by Torchio and Youssef (1968) for *A. flexipes* and Torchio (1971) for *peritomae.* Generally the bees are polylectic but there is a definite preference for the Asteraceae. The males appear to be territorial, defending their territories from conspecific males and other similar-sized bees. The females nest in aggregations usually in earthen banks.

Included Species. A. (Heliophila) abroniae Timberlake, *albata* Cresson, *arthuri* Cockerell, *bispinosa*

FIG. 32. *Anthophora* subgenus *Heliophila,* Vestita and Estebana species groups. A-F, *A. (H.) vestita,* all male except A; G-L, *A. (H.) hololeuca,* all male except L. Numbers are the numbers of the metasomal sterna. A, Head (hair omitted). B, S4-S6, T7, ventral views. C, D, Genital capsule, dorsoventral and side views. E, F, S7 and S8, ventral views. G, H, Genital capsule, dorsoventral and side views. I, J, S7-S8, ventral views. K, T7, dorsal view. L, Hind leg, outer view.


A
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Cockerell, *cockerelli* Timberlake, *columbariae* Timberlake & Cockerell, *erythrothorax* Michener, *estebana* Cockerell, *exigua* Cresson, *flavocincta* Huard, *flexipes* Cresson, *franciscana* Cockerell, *hololeuca* Cockerell, *maculifrons* Cresson, *mortuaria* Timberlake, *nigritula* Cockerell, *pachyodonta* Cockerell, *peritomae* Cockerell, *petrophila* Cockerell, *phenax* (Cockerell), *rhodothorax* Michener, *salazariae* Timberlake, *squammulosa* Dours, *usticauda* Cockerell, *xanthochlora* Cockerell, and *zamoranella* Cockerell. Species in the Estebana group are found in xeric areas of Kansas, Oklahoma and Texas westward to California (including Wyoming), southward to Honduras. A single disjunct record of *A. squammulosa* from Guayaquil, Ecuador, is based on a specimen in the Berlin Museum; the specimen may be mislabeled.

ANTHOPHORA INCERTAE SEDIS

The following species cannot be placed with certainty as to subgenus because the holotypes are females and/or extremely worn specimens, or the types are lost, have been destroyed or not as of yet studied: *A. abjuncta* Cockerell, *acutilabris* Morawitz, *aschabadensis* Radoszkowsky, *bisulca* Pérez, *croceitarsis* Gussakovsky, *dentilabris* Morawitz, *desertorum* Gussakovsky, *doursiana* (Friese), *eversa* Cockerell, *ferghanensis* Gussakovsky, *fixseni* Morawitz, *freimuthi* Fedtschenko, *heliopolitensis* Pérez, *hortensis* Morawitz, *kazabi* Banaszak, *kronebergi* Fedtschenko, *loczyi* Morawitz, *mongolica* Morawitz, *neavei* Vachal, *niveifacies* Hedicke, *nurrana* Cockerell, *occulta* Hedicke, *petersenii* Morawitz, *postica* Vachal, *proxima* Morawitz, *robbi* Cockerell, *sefrensis* Cockerell, *shestakovi* Gussakovsky, *subaequa* Kohl, *submicans* Gussakovsky, *subsericornis* Morawitz, *thomsoni* Saunders, *trichopus* Hedicke, *trifasciata* Radoszkowsky, *usbekistana* Cockerell and *zimini* Cockerell.

Genus *Amegilla* Friese

Diagnosis. Arolia absent (Fig. 9c); hind and midlegs of male simple; hair sometimes metallic, metasoma generally with appressed pubescence (Figs. 33c, e); outer hind tibial spur much isolated from inner tibial spur (Figs. 6a-d); mentum with single anterior tooth near basal third similar to Figure 22k; galea with anterior and posterior lumens (Fig. 5a).

Description. a. Body length 8-24 mm. b. Flagellar segment 1 of female equal to combined lengths of next 2.3-4.2 flagellomeres; of male to next 1.1-2.6 flagellomeres. c. Face of male and female with yellow to white or reddish-yellow to brown integumental markings, rarely all black; clypeus flattened to protuberant, generally .33-.50 width of eye in profile but reaching greatest protrusion in *Glossamegilla* (up to .83); labrum of male apically simple; mentum with anterior tooth on basal third as in Figure 22k (except in *A. nonconforma*), mentum .60-.85 as long as prementum; paraglossa 0.67-1.20 as long as stipes; galea with posterior and anterior lumen chambers (Fig. 5a); flabellum with apical finger-like lobes (Figs. 8e, f). d-f. Midleg with brushes of male absent. g. Hind basitarsus of male simple; hind tibia of female with simple scopal hairs except posterior margin plumose (Fig. 10b). h. Apodeme of S7 .24-.67 length of disc. i. Apex of gonocoxite of male relatively simple, rotund to dorsoventrally flattened, simple to trilobed as viewed ventrally, and expanded to narrowed apically. j. Gonostylus of male often greatly reduced to only a blister, sometimes completely absent (*Notomegilla, Dizonamegilla, Micramegilla, Glossamegilla,* and almost all *Amegilla* s. str. and *Ackmonopsis,* but rarely absent in *Zebramegilla*); when present 1-10 times as long as wide. k. Penis valve apex as viewed apicodorsally 1.4-2.7 times as long as wide, setae small and scattered on surface. l. Bridge of penis valves basally entire to emarginate, apically rounded, never acute, length 0.6-2.8 as long as width. m. Pygidial plate of male absent; T7 of male medioapically with two to three teeth, sometimes shelf-like at base of teeth or basal third to two-thirds thickened dorsoventrally, median longitudinal ridge sometimes present; pygidial plate of female without median longitudinal ridge.

Distribution. Amegilla is found on all Old World continents, Madagascar, the Indomalaysian area and Australia. *Amegilla* is especially speciose in eastern Africa, the Mediterranean region and the Australasian region.

Comments. Many species of *Amegilla,* unlike *Anthophora,* are brightly colored in metallic hues of blue, green and orange hair. These hairs are appressed to the integument, flattened, with apically converging ridges (Figs. 33c-f, 34a, b). The ridges on the hairs presumably diffract the light, producing the color. Pale hair is plumose either in two opposite rows (i.e. feather-like) (Figs. 34e, f), catkin-like (i.e. all around the axis) (Figs. 34c, d) or is simple (Figs. 33a, b).

One remarkable character of female *Amegilla* found by Cane (1979) involves the partial (Figs. 6c, d) to complete (Figs. 6a, b) isolation of the outer hind tibial spur from the corium and inner hind tibial spur (Fig. 6a). A correction of Cane's (1979) Table 1 is that *Amegilla bombiformis* does not have an exoskeletal bridge, only a well developed exoskeletal process (Fig. 6d).

History. The name *Amegilla* was adopted for two North American species with white integumental bands on the metasomal terga by Robertson (1905). Attention was first called to this error by Timberlake (1951) and later by Michener (1960).

Popov (1950) placed many species in *Amegilla* that had previously been included in *Anthophora* though not all belonged there, some being true *Anthophora.* Lieftinck (1944, 1956) gave keys to Malaysian *Amegilla* (he included them in *Anthophora* in 1944) with several new species and redescriptions included. Lieftinck (1975) gave a good redescription using a broad definition of *Amegilla* and further described *Zonamegilla.* Catalogs or simply lists of *Amegilla* species (originally described in *Anthophora*) have been made for species inhabiting India (Cockerell, 1911, a partial key given), the Indian Ocean islands [Cock-

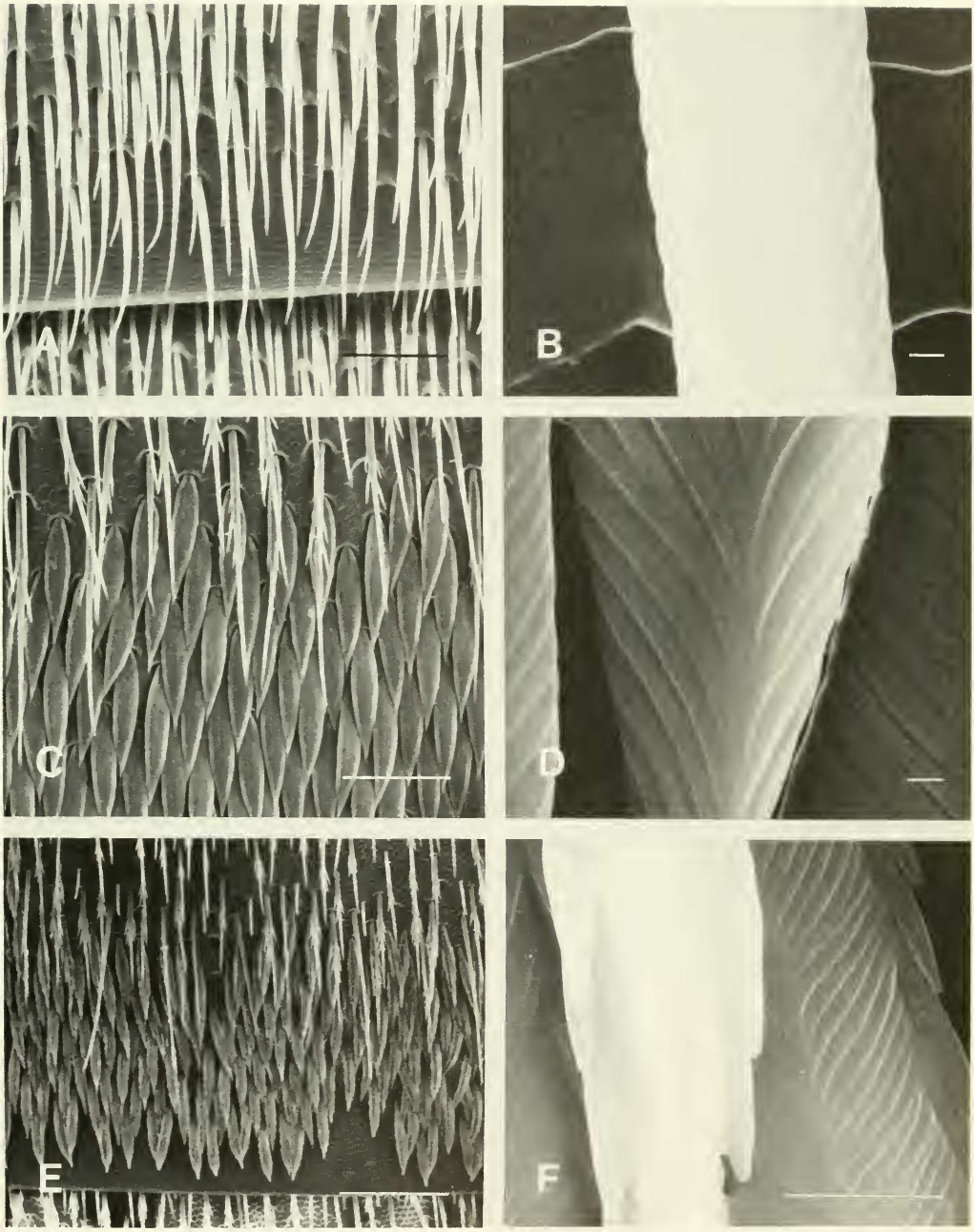


FIG. 33. Metasomal tergal hairs of *Amegilla,* dorsal view. Scale lines represent .1 mm in A, C, E, and .001 mm in B, D, F. A, B, *A. (Glossamegilla) subinsularis* showing simple red hairs (in life) and a close up of a single hair. C, D, *A. (Zonamegilla) cingulifera,* showing the flattened metallic blue-green hair (in the lower three-fourths) on apical margin of tergum and the sparsely plumose black to pale hairs (in life) (in upper one-fourth) and a close up of a flattened hair showing oblique ridges. E, F, *A. (Zebramegilla) quadrata* showing the flattened white hair (middle) and the sparsely plumose hair (top and bottom margins) and a close up of a flattened hair showing the ridges and marginal teeth.

erell, 1912; Saussure, 1890 (Madagascar only)], Australia (Cockerell, 1929, 1931b; Michener, 1965), New Guinea (Friese, 1909) and the Canary Islands (with true *Anthophora*) (Lieftinck, 1958).

KEY TO SUBGENERA OF *AMEGILLA*

1. Seven exposed metasomal terga; thirteen antennal segments, (males). . . 2
— Six exposed metasomal terga; twelve antennal segments, (females) 12
2. Apex of S8 narrowed, either bilobed or rounded such that sternum appears triangular from ventral or dorsal aspect (Figs. 35c, i, k) 3
— Apex of S8 wide, apicomedially emarginate or entire, sometimes apicomedially produced, sternum appearing rectangular from ventral or dorsal aspect (Figs. 36c, e, l) 8
3. Apex of S8 rounded or very weakly bilobed (Figs. 35i, 38c); gonostylus almost always absent, if present then body length at least 12 mm and gonostylus reduced to a blister on gonocoxite 4
— Apex of S8 strongly bilobed (Figs. 35c, k, 37c, 39c); gonostylus present (absent only in the Ethiopian *A. langi* and Indian *niveocincta* whose body lengths are 8-9 mm) as a blister to an elongate appendage 5
4. Apex of S7 only moderately expanded, appearing quadrate, apodeme without lateral tooth (Fig.35h); base of S8 simple, apically pointed (Fig. 35i); Ethiopian, Palearctic and Oriental group . . . . . *Amegilla* s. str.
— Apex of S7 strongly expanded, appearing triangular, apodeme with lateral tooth (Fig. 38d); base of S8 strongly bilobed in ventral aspect (Fig.38c); Australian group . . . . . *Notomegilla*
5. Apical margin of S5 broadly emarginate, if entire, then hair on metasomal terga with metallic blue color (often only visible under a microscope); Australasian. 6
— Apical margin of S5 entire; color of metasomal hair never metallic blue; mainly an Ethiopian groups with a few Oriental species 7
6. Gonostylus well developed (Figs. 39b, g), at least three times as long as wide; S7 without lateral subapical circular area (Fig. 39f); maxillary palpus 5- or rarely 6-segmented; hair on metasomal terga brown, black or gray, never metallic . . . . . *Asaropoda*
— Gonostylus reduced to a blister (Figs. 37a, f), at most as long as wide; S7 with lateral subapical circular area present (Fig. 37c); maxillary palpus 6-segmented; metasomal hair on terga almost always metallic blue, green or orange (except one species in India with white hair) . . . . . *Zonamegilla*
7. Apex of S7 greatly expanded laterally, much broader than long (Fig. 35l); only T3 and T4 with pale apical bands of hair; body length 14-18 mm; northeast Africa, India, Timor. . . . . *Dizonamegilla*
— Apex of S7 laterally expanded normally, about as broad as long (Fig. 35d); all metasomal terga with pale apical bands of hair (except for a Ghanan species which has T1 all black); body length 8-14 mm; mainly African group with only two Indian species . . . . . *Zebramegilla*
8. Gonostylus absent (Figs. 37f, 38h). . 9
— Gonostylus present, varying from a blister to an elongate appendage (Figs. 36a, f, k) 10
9. Galea long, in repose reaching at least to middle of midcoxa, at least 3 times as long as foretibia (galea measured from apex to maxillary palpus); apex of S8 emarginate between a pair of large obtuse lobes (Fig. 38f); Oriental species, mainly Indomalaysian (there are three Indian species which are at least 13 mm in length and their metasomal terga with all black hair or at least anterior half with orange hair) . . . . . *Glossamegilla*
— Galea of moderate length, reaching in repose at most to anterior edge of midcoxa, at most 2.5 times as long as foretibia (galea measured as above); apex of S8 relatively narrowly emarginate between a pair of small obtuse lobes (Fig. 37i) or with a single median

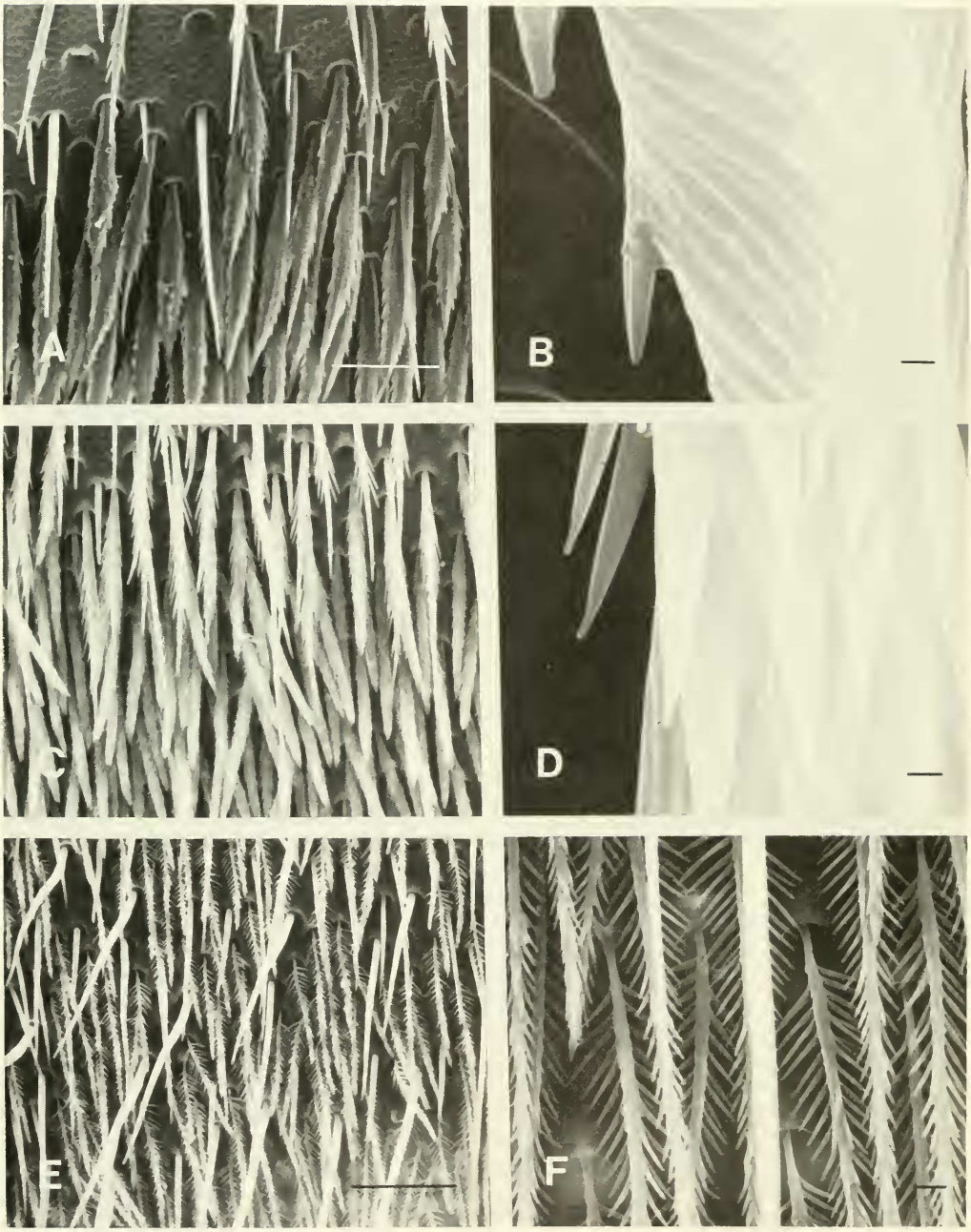


FIG. 34. Metasomal tergal hairs, dorsal view. Scale lines represent .1 mm in A, C, E, and .001 mm in B, D, F. A, B, *Amegilla (Dizonamegilla) sesquicincta,* showing flattened hairs (white in life) in lower two-thirds of Figure A and round hairs (black in life) in upper third and a close-up of a flattened hair showing oblique ridges in Figure B. C, D, *Amegilla (Zebramegilla) albigena,* showing white round hairs the shape of wheat tassles and a close-up of a single hair showing the longitudinal ridges. E, F, *Anthophora (Heliophila) bimaculata,* showing plumose (ochraceous in life) and simple (black or pale in life) hair and a close-up of same.

lobe; mainly Ethiopian species (there are two Indian species which are at most 12 mm in length and metasomal terga with pale apical bands) . . . . . *Micramegilla*

10. Apex of S7 with normal lateral expansion, midsection of disc without or with slight lateral tooth (Figs. 36d, i); S8 with apical emargination between pair of obtuse submedian lobes (Figs. 36c, l) 11
— Apex of S7 wide, with well developed lateral expansion, midsection of disc with well developed lateral tooth (Fig. 36h); S8 with apical margin entire or apicomedially with slight protuberance (Fig. 36e). . . . . *Ackmonopsis*
11. S8 with lateral margins of apical half to two-thirds converging distally (Fig. 36l); apex of gonocoxite from ventral aspect with small lobe on inner margin (Fig. 36k); basitibial plate sometimes present . . . . . *Aframegilla*
— S8 with lateral margins of apical half to two-thirds diverging distally (Fig. 36c); apex of gonocoxite from ventral aspect expanded and rounded, inner margin simple without lobe (Fig. 36a); basitibial plate absent . . . *Megamegilla*
12. Hair of metasomal terga metallic (sometimes only visible under a microscope), green, blue-green, blue or red-orange 13
— Hair of metasomal terga not metallic, white to ochraceous, brown, orange, yellow, gray or black 16
13. Galea usually moderate to short in length, reaching in repose at most to anterior edge of hind coxa, length at most 2.5 times length of foretibia (galea measured from apex to maxillary palpus); paraocular marks present or absent; Australian, Oriental or African groups 14
— Galea long, reaching in repose from middle to posterior edge of hind coxa, length about 3 times length of foretibia (galea measured from apex to maxillary palpus); paraocular marks absent; Malaysian group . . . . . *Glossamegilla* (in part)
14. Paraocular marks present; Australian or Oriental groups 15
— Paraocular marks absent; African groups . . . . . *Aframegilla* (in part)
15. Maxillary palpus with four, occasionally five segments; galea in repose reaching at most to anterior edge of midcoxa, length about twice as long as foretibia; length of flagellomere 1 equal to the combined lengths of the next 3.0-3.1 segments; Australian group . . . . . *Notomegilla*
— Maxillary palpus with six segments; galea in repose reaching at least past posterior edge of midcoxa, length 2.5 times as long as foretibia; flagellomere 1 equal to the combined lengths of the next 2.3-2.8 segments; Southeast Asian, Indian, Indomalaysian and Australian. . . . . *Zonamegilla* (in part)
16. Paraocular marks absent (Fig. 39d); maxillary palpus with five or six segments. 17
— Paraocular marks present (Figs. 37k, l); maxillary palpus with six segments 28
17. Ethiopian, Palearctic, or Oriental species; clypeus with pale integumental marking in form of inverted 'T' (Figs. 37k, l) or clypeus all to almost all black 18
— Australian species; clypeus completely pale except for small dark mark at anterior tentorial pit . . . . . *Asaropoda*
18. All metasomal terga with apical bands of hair, white to ochraceous. 19
— Some metasomal terga without apical bands of hair and/or with visible portion of some or all terga covered with dense, appressed white, ochraceous, yellow or orange pubescence 21
19. Posterior edge of hind tibia white without black band of scopal hairs . . . 20
— Posterior edge of hind tibia with band of black scopal hairs extending distally from basitibial plate to apical third. . . . . *Ackmonopsis* (in part)
20. Body length at most 12.5 mm; metasomal width at most 4.6 mm; length of flagellomere 1 equal to combined lengths of next 2.5-3.0 segments . . . . . *Micramegilla* (in part)
— Body length at least 12.7 mm; metaso-

mal width at least 5.0 mm; length of flagellomere 1 equal to combined lengths of next 3.0-3.3 segments . . . . . *Amegilla* s. str. (in part)

21. Pubescence of thorax brown to orange (sometimes with scattered dark hair); metasomal hairs usually almost all black, sometimes visible portions of terga with appressed white hair from apical margin of T3-T5 22
— Pubescence of thorax white, ochraceous, brown, black, or black and yellow (sometimes with scattered dark hair); metasomal terga with apical bands of hair and/or appressed hair on visible portions of T1-T5 or if T1-T3 (excluding apical margin of T3) all black, then scutum with white hair, black intermixed. 23

22. Maxillary palpus with five segments; body length at least 16 mm; length of flagellomere 1 equal to the combined lengths of next 3.0-4.2 segments . . . . . *Megamegilla* (in part)
— Maxillary palpus with six segments; body length at most 14 mm; length of flagellomere 1 equal to the combined lengths of next 3.0 segments. . . . . *Ackmonopsis* (in part)

23. Palearctic and Ethiopian species; clypeus with inverted T-shaped mark or reduced to a median longitudinal line, if clypeus all black then species from the Cape Verde Islands 24
— Oriental species (Indian region); clypeus all black or with small mark basomedially . . *Glossamegilla* (in part)

24. Scopal hair on outer surface of hind tibia all white (sometimes with a small patch of dark hair near basitibial plate) or all orange 25
— Scopal hair on outer surface of hind tibia all black. 26

25. Length of flagellomere 1 equal to combined lengths of next 2.5-3.0 segments; scutum with all white to ochraceous hair, no black intermixed or species almost all black with orange scopa . . . . . *Micramegilla* (in part)
— Length of flagellomere 1 equal to combined lengths of next 3.4-3.6 segments; scutum with brown to orange hair with some black intermixed or black and white intermixed . . . . . *Amegilla* (in part)

26. Metasoma either with T4 covered with white hair, T5 with lateral patch of white hair and remaining terga black or with T1 or T2-5 with appressed ochraceous to orange hair, not with distinct apical bands of hair though hair sometimes gradually becomes denser near apical tergal margins 27
— Metasomal T2-T5 with apical bands of white hair, without appressed pale hair on visible portions of terga. . . . . *Zebramegilla* (in part)

27. Maxillary palpus with five segments; pale mark on clypeus reduced so that inverted T-shaped mark is small, sometimes only represented by a median longitudinal line; supraclypeal mark small, almost absent . . . . . *Megamegilla* (in part)
— Maxillary palpus with six segments; inverted T-shaped pale mark of clypeus well developed; supraclypeal mark well developed (Figs. 43f, l) . . . . . *Aframegilla* (in part)

28. Species found in Oriental or Eastern Palearctic regions (East of 65th meridian) 29
— Species found in Ethiopian or Western Palearctic regions (West of 65th meridian) 33

29. T1 and T2 all black with no pale apical bands or appressed brown hair (T2 sometimes with white patch of hair laterally). 30
— T1 and T2 with pale apical bands of hair (sometimes weakly developed on T2) or most of visible portions of T1 and T2 with appressed brown hair (sometimes very sparse or absent medially) 31

30. Metasomal terga all black except a patch of white hair laterally on T5; propodeum with black hair . . . . . *Glossamegilla* (in part)
— T4 and sometimes T3 with apical bands of white hair; propodeum with white hair. . . . *Dizonamegilla* (in part)

31. Length at most 9 mm; thorax predominately with white hair, some

black intermixed; metasomal terga with apical bands of pale hair . . . 32

— Length at least 12 mm; thorax with brownish red hair, sometimes with black intermixed; metasomal terga with apical bands of brown hair, usually with appressed brown hair on some or all visible portions of terga, apically condensing into bands . . . . . *Glossamegilla* (in part)

32. Scape with yellow integumental marking anteriorly; paraocular mark large, ocular angle of mark at nearly same level as clypeal angle (Fig. 37k) *(A. niveocincta)* . . . . . *Zonamegilla* (in part)

— Scape with brown integumental mark anteriorly; paraocular mark normal, ocular angle of mark well below level of clypeal angle (Fig. 37l) (*A. quadrata* and *subcoerulea*) . . . . . *Zebramegilla* (in part)

33. Length at least 15 mm; at least T1 and T2 all black, without apical bands of pale hair. 34

— Length at most 14 mm; T1-T5 with apical bands of pale hair . . . . . *Zebramegilla* (in part)

34. Yellow hair on scutum and apical margin of T2 and visible portions of T3-T6 *(A. atrocincta)*. . . . . *Micramegilla* (in part)

— White mixed with black hair on scutum; T1-T4 all black *(A. somalica)*. . . . . *Dizonamegilla* (in part)

Zebramegilla new subgenus

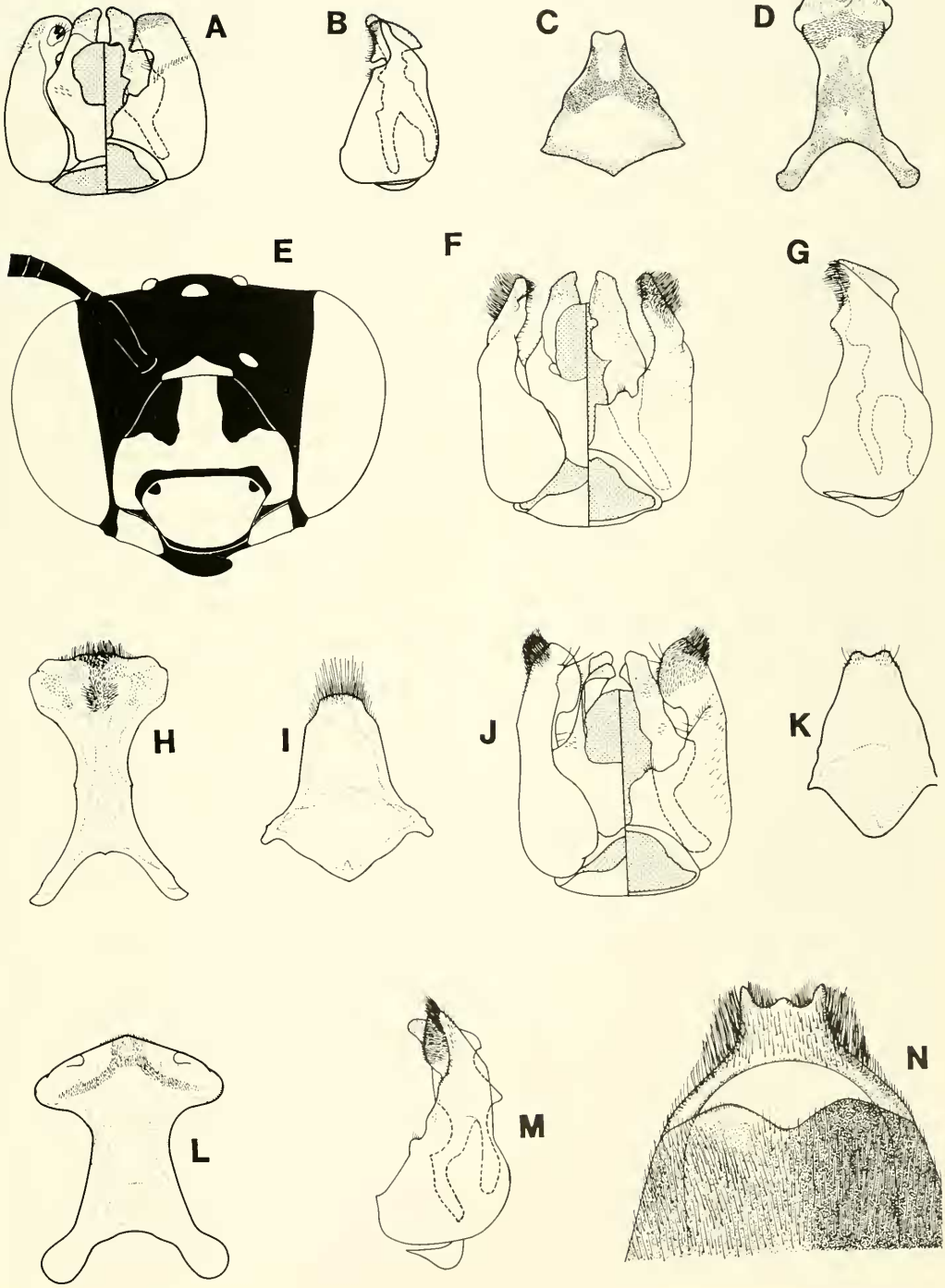
Type species: *Anthophora albigena* Lepeletier, 1841.

Diagnosis. Length 8-14 mm; S6 of male entire to shallowly emarginate; apex of S7 of male entire and rounded or trilobed, apicolateral margin rounded to angulate, submedian circular area present (Fig. 35d); apex of S8 of male apically narrowed, lateral margins on distal third to half converging distally (Fig. 35c); apex of gonocoxite of male dorsoventrally flattened, bent inward, inner apical margin subtruncate to rounded (Figs. 35a, b); gonostylus of male present (except the African *A. langi* absent) but reduced to a blister; T1-T5 with complete apical bands of hair (except *atribasis* with T1 all black).

Description. a. Length 8-14 mm. b. Flagellar segment 1 of female equal to length of next 2.5-4.0 segments together, of male equal to length of next 1.3-2.5 segments together. c. Mentum about .7 as long as prementum; paraglossa about as long as stipes; galea in repose attaining hind edge of forecoxa to anterior edge of midcoxa; maxillary palpus 6-segmented and labial palpus 4-segmented; face with white to yellow markings, paraocular marks present in male and female; wings clear (infuscated in *A. grandiceps*). d. Basitibial plate present in male. e. S6 of male medioapically entire to shallowly emarginate, disc flat (except *langi,* and *subcoerulea*), disc with lateral subapical depression, median longitudinal ridge on apical third (apicolateral margin with raised bump in *langi*). f. Apex of male S7 entire, apical margin straight to weakly trilobed with small acute lobe on each side of median one (except *michaelis* bilobed with broad emargination), lateral subapical carina often present, circular area present (except in *atribasis*); middle of expanded portion of disc sometimes with two submedian longitudinal ridges or a median tubercle on apical sixth but usually simple with a large patch of hair; apicolateral margin of disc expanded laterally either round or angulate, sometimes bilobed with a round (rarely carinate) dorsal lobe and a round ventral lobe; lateral margin on basal half simple or with lateral protuberance; longitudinal sclerotization present; length of apodeme .35-.55 length of disc (Fig. 35d). g. Apex of S8 of male narrowed, apicomedially bilobed (*atribasis* appearing quadrilobed); lateral margins on apical third to half converging distally, on basal half to two-thirds with weak lateral protuberance (Fig. 35c). h. T7 of male apicomedially tabulate usually with basal third to two-thirds thickened dorsoventrally, with two teeth, apical margin between teeth often with median lobe sometimes entire; T1-T5 with complete apical bands (except *atribasis* with T1 all black). i. Apex of gonocoxite of male on inner margin bent at almost a 90 degree angle inward, sometimes large, blunt, only slightly dorsoventrally flattened, subtruncate (Figs. 35a, b). j. Gonostylus of male present (in *langi* absent) as a blister. k. Apex of penis valve 2.0-2.7 times as long as broad, with small, scattered setae. l. Bridge of penis valves 1.0-2.6 times as long as wide, basally emarginate (except entire in *circulata*).

Etymology. Zebra (Amharic), Abyssinian name for the striped equine of Africa, plus *Megilla,* the name applied to a related taxon and serving as a

FIG. 35. *Amegilla* subgenera *Zebramegilla, Amegilla* s. str., and *Dizonamegilla.* A-D, *A. (Z.) albigena,* male; E-I, *A. (A.) quadrifasciata,* all male except E; J-N, *A. (D.) sesquicincta,* male. A, B, Genital capsule, dorsoventral and side views. C, D, S8 and S7, ventral views. E, Head. F, G, Genital capsule, dorsoventral and side views. H, I, S7 and S8, ventral views. J, Genital capsule, dorsoventral view. K, L, S8 and S7, ventral views. M, Genital capsule, side view. N, S6 and T7, ventral views.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stem for various names in this genus. The name *Zebramegilla* refers to the striped metasomas of this mainly Ethiopian group.

Comments. Many of the species of *Zebramegilla* are similar and difficult to separate. More synonymy will probably be established in the course of revisionary studies. Alfken (1926, p. 117) gave a key to four species of *Zebramegilla* from Egypt. *A. salviae* (Morawitz) is a valid name and need not be replaced by *A. pipiens* (Mocsáry) (see *Comments* for *Anthophora* s. str.)

Zebramegilla is closely related to *Amegilla* s. str. and can be separated from that subgenus by the characters given in the *Comments* for *Amegilla* s. str.

Biology. In subsaharan Africa the adults fly from August to May. In the Mediterranean region to India they fly from July to December.

Included Species. A. (Zebramegilla) albigena (Lepeletier), *alboscopacea* (Friese) new combination, *antimena* (Saussure), *atribasis* (Cockerell) new combination, *bechuanensis* (Cockerell) new combination, *bequaerti* (Cockerell), *calens* (Lepeletier), *cerealis* (Cockerell) new combination, *circulata* (Fabricius), *crocea* (Klug) new combination, *diloloensis* (Cockerell) new combination, *disrupta* (Cockerell) new combination, *eritrina* (Friese) new combination, *fallax* (Smith), *felina* (Friese), *ferrocincta* (Cockerell) new combination, *graeca* (Alfken) new combination, *grandiceps* (Friese) new combination, *harttigi* (Alfken), *kaimosica* Cockerell new combination, *langi* (Cockerell) new combination, *lomamica* (Cockerell) new combination, *madecassa* (Saussure) new combination, *mediorufa* (Cockerell) new combination, *melanocera* (Cockerell) new combination, *melanodonta* (Cockerell) new combination, *michaelis* (Cockerell) new combination, *nigritarsis* (Friese) new combination, *nubana* (Cockerell) new combination, *obscuriceps* (Friese), *ogilviei* (Cockerell) new combination, *omissa* (Priesner) new combination, *punctifrons* (Walker), *quadrata* (Cockerell) new combination, *rubricans* (Cockerell), *salviae* (Morawitz), *savignyi* (Lepeletier), *spilostoma* (Cameron), *subcoerulea* (Lepeletier), *supraferrea* (Cockerell) new combination, *talaris* (Pérez), *vanderysti* (Cockerell) new combination, and *zinniae* (Cockerell) new combination. This large group is found throughout Africa, the Mediterranean region to southern India.

Subgenus *Amegilla* Friese s. str.

Amegilla Friese, 1897, p. 18.

Type species: *Apis quadrifasciata* de Villers, 1789, designated by Cockerell, 1931a, p. 277.

Alfkenella Börner, 1919, p. 168.

Type species: *Apis quadrifasciata* de Villers, 1789. Original designation.

Diagnosis. Length 11.0-16.5 mm; S7 apically entire (see *Description*) with lateral subapical lightly sclerotized circular area (Fig. 35h); S8 apically more or less rounded (Fig. 35i); gonocoxite of male weakly bilobed apically as seen in profile; gonostylus of male absent (in *A. capensis* and *ochroleuca* reduced to blister); paraocular marks of female absent (Fig. 35e); metasomal terga with complete apical bands of hair, not metallic.

Description. a. Length 11.0-16.5 mm. b. Flagellar segment 1 of female equal to length of next 3.0-3.6 segments together, of male equal to length of next 1.2-1.8 segments together. c. Mentum .72-.85 as long as prementum; paraglossa 0.67-1.00 as long as stipes; galea in repose attaining anterior edge to middle of midcoxa; maxillary palpus 6-segmented; labial palpus 4-segmented; face with white markings (yellow in *A. capensis*), paraocular marks of female absent, of male well developed; wings clear (infuscated in some *quadrifasciata*). d. Male with basitibial plate. e. S6 of male narrowly and shallowly emarginate apicomedially (*garrula* and *confusa* with a small apicomedian protuberance). f. S7 of male apically entire (*garrula* and *confusa* broadly but shallowly emarginate) and with apicomedian patch of hair, apicolaterally weakly bilobed (single lobe in *capensis*), inner more weakly produced lobe ventral to outer dorsolaterally projected lobe; apex laterally with subapical lightly sclerotized circular area (absent in *capensis*); lateral margin of basal half with short tooth; disc with longitudinal sclerotization, length of apodeme .36-.43 length of disc (Fig. 35h). g. S8 of male more or less apically round, sometimes very weakly bilobed, lateral margin of apical half almost straight (Fig. 35i). h. T7 of male apicomedially bilobed; metasomal terga with complete apical bands of hair, not metallic. i. Apex of gonocoxite of male bilobed in profile, lateral margin of apical third somewhat angulate outwardly as viewed from ventral aspect, protuberance of lower ventral surface present to absent as viewed in profile, hair profuse to sparse on apicoventral surface (Figs. 35f, g). j. Gonostylus of male apparently absent, usually with gonostylar-like setae still present (except *capensis* and *ochroleuca* gonostylus present, but reduced to a blister). k. Apex of penis valve 1.4-2.1 times as long as wide as viewed apicodorsally; short, small setae present. l. Bridge of penis valves 1.2-1.6 times as long as wide, basally broadly emarginate to entire.

Comments. Amegilla s. str. is most closely related to *Zebramegilla* from which the males are separated by the S8 being not nearly as narrowed and rounded apically (Fig. 35i), its apodeme elongate and protruding and by S7 having a dense median patch of hair on its apex. Even though there is a size overlap between the two subgenera, most *Amegilla* s. str. are larger than *Zebramegilla.*

Alfken (1927) gave a key to some members of *Amegilla* s. str.

Biology. In southern and eastern Africa the adults are active from December to April. In the Northern Hemisphere the adults fly from February to October.

Included Species. A. (Amegilla) canifrons (Smith), *capensis* (Friese) new combination, *confusa* (Smith) new combination, *elgonica* (Cockerell) new combi-

nation, *farinosa* (Klug), *garrula* (Rossi), *incana* (Klug) new combination, *mauritanica* (Benoist) new combination, *ochroleuca* (Pérez), *quadrifasciata* (de Villers), *socia* (Klug) new combination, and *xerophila* (Cockerell) new combination. Members of this subgenus are found in eastern and southern Africa, the Mediterranean region, Central Europe, eastward to northern India.

Dizonamegilla new subgenus

Type species: *Megilla sesquicincta* Erichson and Klug, 1842 (=*Apis bicincta* Fabricius, 1793, nec Schrank, 1781).

Diagnosis. Length 14-18 mm; apex of S7 of male medioapically entire, produced bluntly and expanded laterally without lightly sclerotized submedian circular area (Fig. 35l); apex of S8 of male narrowly tapered, weakly bilobed, lateral margin almost straight (Fig. 35k); gonocoxite apically expanded, dorsoventrally flattened (Fig. 35j); gonostylus present, reduced to a blister.

Description. a. Length 14-18 mm. b. Flagellar segment 1 of female equal to length of next 3.2-3.5 segments together, of male about equal to length of next 1.7 segments together. c. Mentum .7 as long as prementum; paraglossa about as long as stipes; galea in repose surpassing slightly anterior edge of midcoxa; maxillary palpus with 6 segments; labial palpus with 4 segments; face with white markings, paraocular marks present in male but small, and in female well developed; wing infuscated. d. Basitibial plate present in male. e. S6 of male narrowly emarginate apicomedially (Fig. 35n). f. S7 of male medioapically entire, produced bluntly, apicolateral margin with large lobe, submedian circular area absent, carinate C-shaped area on apicosubmedian margin; disc with longitudinal sclerotization; length of apodeme about one-third length of disc (Fig. 35l). g. S8 of male with apex narrow, bluntly bilobed, lateral margin almost straight (Fig. 35k). h. T7 of male medioapically shelf-like, dorsoventrally flattened with median longitudinal ridge, and apically trilobed, median lobe about one-third length of lateral lobe (Fig. 35n). i. Gonocoxite of male apically simple, expanded, dorsoventrally flattened, (Figs. 35j, m). j. Gonostylus of male apparently absent. k. Apex of penis valve about 1.8 times as long as wide viewed apicodorsally, with small scattered setae. l. Bridge of penis valves about 1.1 times as long as wide, basally emarginate.

Etymology. The name *Dizonamegilla* refers to the two white bands of hair on an otherwise all black metasoma of the type species.

Comments. The relationship of *Dizonamegilla* with other subgenera of *Amegilla* remains obscure. However, its affinities seem to be with *Amegilla* s. str. and *Zebramegilla* from which it is separated by the limitation of apical bands of metasomal hair to the last two or three segments, by the laterally expanded apex of the male S7 and by the apically rounded apices of the male gonocoxites.

The name *Apis bicincta* Fabricius, 1793 is not available for the type of *Dizonamegilla* because of homonymy. The next available name is *Megilla sesquicincta* Erichson and Klug, 1842. The supposed type material of *sesquicincta* is in Berlin but none of the four specimens there is from the type locality nor of the proper sex. These specimens, however, are the same as *A. bicincta* Fabricius as traditionally interpreted. Since *sesquicincta* and *bicincta* Fabricius are the same species judging from their descriptions, the distinctiveness of the species, their type localities (both from India), and the Erichson and Klug material of *M. sesquicincta* in Berlin, I here designate a neotype of *Megilla sesquicincta* Erichson and Klug (see Neotypic Designations).

Biology. The adults are active from November to April.

Included Species. A. (Dizonamegilla) sesquicincta (Erichson and Klug) new combination, *somalica* (Magretti) new combination, and *tetrataeniata* (Gribodo) new combination. Each of three species of this subgenus occurs in a different region. *A. somalica* occurs in Somalia, *sesquicincta* in India and *tetrataeniata* in Timor.

Megamegilla new subgenus

Type species: *Apis acraensis* Fabricius, 1793.

Diagnosis. Length 13-19 mm; apex of S7 of male medioapically entire, laterally expanded, without lateral subapical circular area (Fig. 36d), median section of disc narrow; S8 of male apically broad, with apicomedian emargination, lateral margins either diverging or parallel distally (Fig. 36c); apex of gonocoxite of male dorsoventrally flattened (Fig. 36a); gonostylus of male present; basitibial plate of male absent; maxillary palpus with five segments.

Description. a. Length 13-19 mm. b. Flagellar segment 1 of female equal to length of next 3.0-3.7 segments together, of male about equal to length of next 1.6-2.0 segments together. c. Mentum about .75 as long as prementum; paraglossa about as long as stipes; galea in repose attaining anterior to posterior edge of midcoxa; maxillary palpus with 5 segments; labial palpus with 4 segments; face with white markings, paraocular mark present in male, present to absent in female; wing infuscated. d. Basitibial plate absent in male. e. S6 of male narrowly emarginate and sometimes ventrally flexed medioapically, at base of emargination a transverse depression sometimes present. f. S7 of male apicolaterally expanded, entire; median area of disc narrowed greatly; disc with longitudinal sclerotization; length of apodeme .24-.40 length of disc (Fig. 36d). g. S8 of male apically broad, emarginate medioapically, lateral margins either parallel or diverging distally (Fig. 36c). h. T7 of male medioapically bilobed. i. Apex of gonocoxite of male dorsoventrally flattened and expanded (Figs. 36a, b) (inner margin with lobe in *acraen-*

sis). j. Gonostylus of male like a blister to 6 times as long as wide. k. Apex of penis valve 2.0-2.4 times as long as wide viewed apicodorsally, with small and scattered setae on surface. l. Bridge of penis valves 0.6-1.0 times as long as wide, broadly emarginate basally.

Etymology. Megas (Gr.), large, plus *Megilla,* the name of a related taxon. *Megamegilla* refers to the large size of the bees of this group.

Comments. Megamegilla is closely related to *Aframegilla* and *Ackmonopsis*. It can be readily separated from these two by its large size, lack of metallic hair, lack of pale marks on the male scape, narrowly emarginate apex of male S8 without small pair of protruding lobes and laterally angulate rather than rounded. Except for the melanic forms (e.g., the *tellervo* form of *acraensis*) whose thoracic hair is a mixture of black and white), these bees are typically with dark heads with or without pale brown to yellow thoracic hair and black metasomas with or without white hair on the last two to three segments.

Biology. The adults fly from April to February.

Included Species. A. (Megamegilla) acraensis (Fabricius), *albocaudata* (Dours) new combination, *nativitatis* (Cockerell) new combination, *nigroclypeata* (Friese) new combination and *paradoxa* n. sp. *Megamegilla* is Ethiopian, found south of latitude approximately 15° North including Yemen.

Subgenus *Aframegilla* Popov

Aframegilla Popov, 1950, p. 260.

Type species: *Anthophora nubica* Lepeletier, 1841. Original designation.

Diagnosis: Metasomal dorsum (as well as thorax sometimes) of many species with metallic blue or green hair; apex of male gonocoxite, from ventral view, with an inwardly projecting blunt to acute process (Fig. 36k); gonostylus of male membranous to completely sclerotized (concolorous with apex of gonocoxite); S7 of male with apicolateral margin angulate (Fig. 36i); S8 of male with apex wide, shallowly emarginate medially, apicolaterally with small lobe (Fig. 36l).

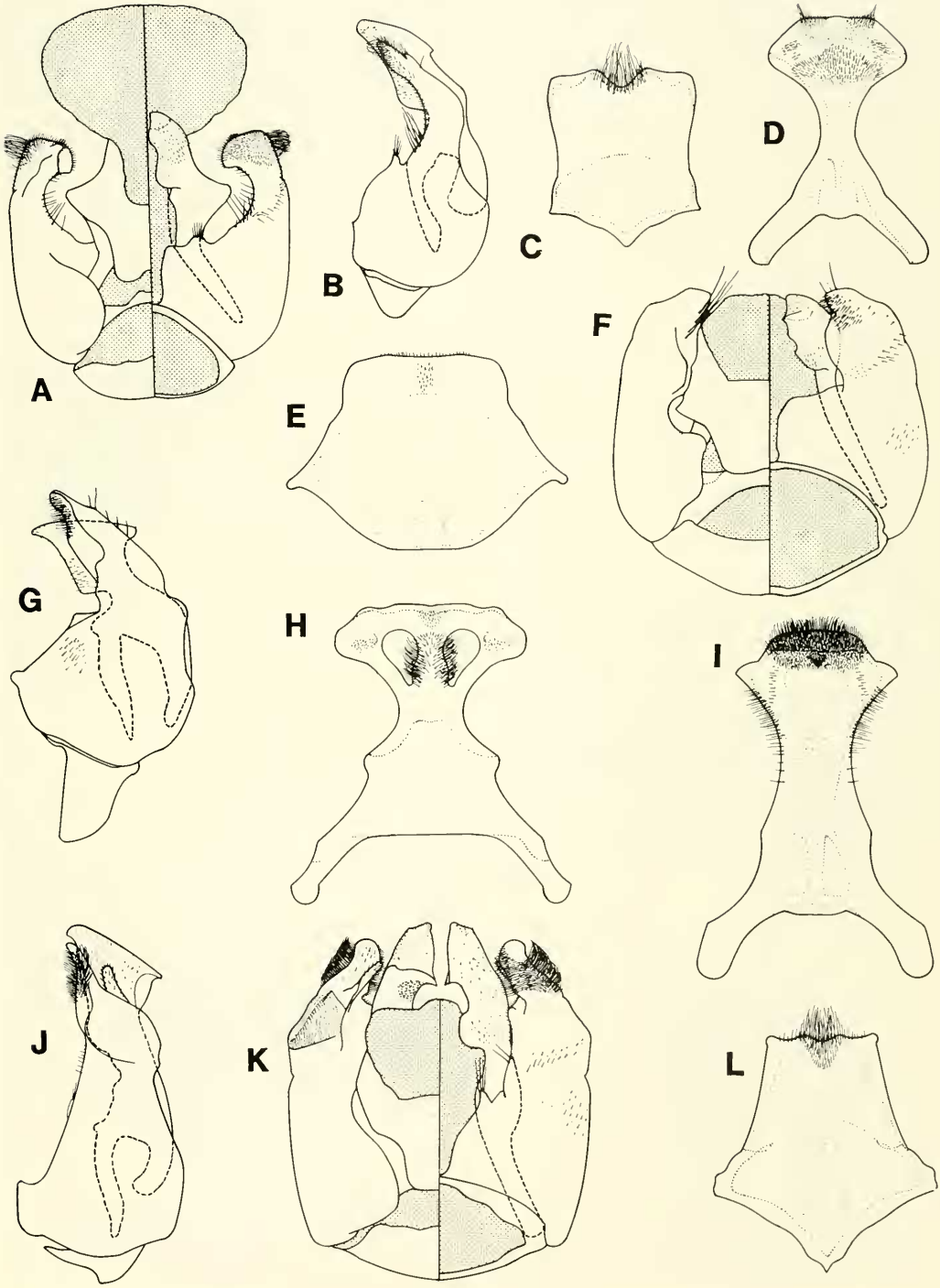
Description. a. Length 11.0-15.5 mm. b. Flagellar segment 1 of female equal to length of next 3.0-4.2 segments together, of male equal to length of next 1.7-2.6 segments together. c. Mentum about three-fourths as long as prementum; paraglossa about .7 as long as stipes; galea in repose attaining at most posterior edge of hind coxa; maxillary palpus with 6 segments; labial palpus with 4 segments; face with white integumental markings (yellow in *A. africana, robinae* and *triangulifera*), paraocular marks absent in female, well developed in male (absent in *cincta*); wing clear to infuscated. d. Basitibial plate of male absent to present. e. S6 of male apicomedially shallowly emarginate. f. S7 of male with apex medially emarginate, or produced, or rounded; lateral margin angulate apicolaterally and weak tooth on basal half (Fig. 36i) (an undescribed species from Magadi, Kenya with weakly developed tooth on basal three-fourths); disc with longitudinal sclerotization, length of apodeme .29-.40 length of disc (Fig. 36i). g. S8 of male with broad apex, apical margin variable from broadly to narrowly emarginate, to apicomedially produced and narrowly rounded, lateral margin of apical half relatively straight to lobed at basal half (Fig. 36l); longitudinal sclerotization present to absent. h. T7 of male medioapically bilobed to trilobed. i. Inner apical margin of gonocoxite of male, in ventral view, with acute to blunt lobe (Fig. 36k). j. Gonostylus of male membranous to sclerotized, when sclerotized, gonostylus not demarcated from gonocoxite (Fig. 36k), rounded (about as long as broad) to elongate (about 6 times as long as wide); ventral lobe of gonocoxite of male present. k. Apex of penis valve 1.2-2.2 times as long as wide as viewed apicodorsally, with small scattered setae. l. Bridge of penis valves 0.8-1.8 times as long as wide, basally broadly emarginate (except *aerizusa* basally entire).

Comments. Aframegilla is closely related to *Megamegilla* and *Ackmonopsis* and can be separated from them by the usual presence of a well developed male gonostylus, by the male S7 apicolaterally being acutely angulate, by the apicolateral margin of the male S8 having a small rounded lobe and usually by the presence of metallic hair. All African species of *Amegilla* with blue or metallic green tergal hair belong in *Aframegilla.* Nontypically, *A. africana* is covered with orange hair and the legs are all black and *nubica* has essentially a white thorax and black metasoma with T4 in the female (T3-T5 in male) covered with white hair.

Biology. The adults fly from October to July.

Included Species. A. (Aframegilla) aerizusa (Vachal), *africana* (Friese) new combination, *bothai* (Friese) new combination, *caelestina* (Cockerell) new combination, *caerulea* (Friese), *cincta* (Fabricius), *cyanipennis* (Saussure) new combination, *elsei* n. sp., *guinea* (Strand) new combination, *nubica* (Lepeletier), *regalis* (Cockerell) new combination, *robinae* n. sp., *terminata* (Smith), *triangulifera* (Cockerell) new combination and *vivida* (Smith) new combination. This Ethiopian subgenus only occurs south more or less of latitude 15° North.

FIG. 36. *Amegilla* males, subgenera *Megamegilla, Ackmonopsis,* and *Aframegilla.* A-D, *A. (M.) acraensis;* E-H, *A. (Ackmonopsis) mimadvena;* I-L, *A. (Aframegilla) nubica.* A, B, Genital capsule, dorsoventral and side views. C, D, S8 and S7, ventral views. E, S8, ventral view. F, G, Genital capsule, dorsoventral and side views. H, S7, ventral view. I, S7, ventral view. J, K, Genital capsule, side and dorsoventral views. L, S8, ventral view.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Ackmonopsis new subgenus

Type species: *Anthophora mimadvena* Cockerell, 1916.

Diagnosis. Length 12-15 mm; apex of S7 of male medioapically entire, greatly expanded laterally, submedian circular area present, basal half of disc relatively broad, with lateral tooth (Fig. 36h); S8 with broad apex essentially entire to weakly emarginate (Fig. 36e); apex of gonocoxite of male dorsoventrally flattened with inner margin bilobed or trilobed (Figs. 36f, g); gonostylus of male absent (a blister in *A. mimadvena*); basitibial plate of male present.

Description. a. Length 12-15 mm. b. Flagellar segment 1 of female about equal to length of next 3 segments together, of male equal to length of next 1.6-1.9 segments together. c. Mentum about .7 as long as prementum; paraglossa about as long as stipes; galea in repose attaining anterior edge of midcoxa; maxillary palpus with 6 segments; labial palpus with 4 segments; face with white or yellow markings, paraocular marks present in male, absent in female; wing infuscated. d. Basitibial plate present in male. e. S6 of male broadly, shallowly emarginate, apical margin flexed ventrally. f. Apex of S7 of male entire, margin rounded to straight, laterally expanded, anvil shaped, submedioapical circular area present, median patch of hair present, lateral margin on basal half with tooth; longitudinal sclerotization present; length of apodeme .37-.40 length of disc (Fig. 36h). g. S8 of male apically broad, apicomedially with shallow emargination to entire, lateral margins on apical fourth almost parallel (Fig. 36e). h. T7 of male apicomedially with shelf-like process, bilobed (weakly trilobed in *arcana*). i. Apex of gonocoxite of male with inner margin bilobed to trilobed as viewed from dorsal or ventral aspect, dorsoventrally flattened (Figs. 36f, g). j. Gonostylus of male absent (a blister present in *mimadvena*); ventral lobe of gonocoxite of male lightly sclerotized to absent. k. Apex of penis valve about 1.6 times as long as wide viewed apicodorsally, with small scattered setae. l. Bridge of penis valves 0.7-1.0 times as long as wide, broadly emarginate basally.

Etymology. Ackmon (Gr.), anvil, plus *opsis* (Gr.), having the appearance of, with reference to the apically broad S7 of the male.

Comments. Ackmonopsis appears to be closely related to *Aframegilla* and *Megamegilla.* It can be separated from *Megamegilla* by the smaller size, 6-segmented maxillary palpus and the pale marks on the scapes of the males. The subgenus can be separated from *Aframegilla* by the lack of metallic hair and the loss or great reduction of the gonostylus of male. Moreover, *Ackmonopsis* can be differentiated from the other two by the greatly expanded apex of the male S7 and by the simple shape of the male S8.

Biology. The adults in southern and central Africa fly from September to April. In Ethiopia and Yemen they fly from July to December. *A. arcana* and *mimadvena* look superficially like members of *Megamegilla,* probably due to Müllerian mimicry.

Included Species. A. (Ackmonopsis) arcana (Cockerell) new combination, *griseotecta* (Cockerell) new combination, and *mimadvena* (Cockerell) new combination. *Ackmonopsis* is found in eastern, central and narrowly into western Africa as well as Yemen.

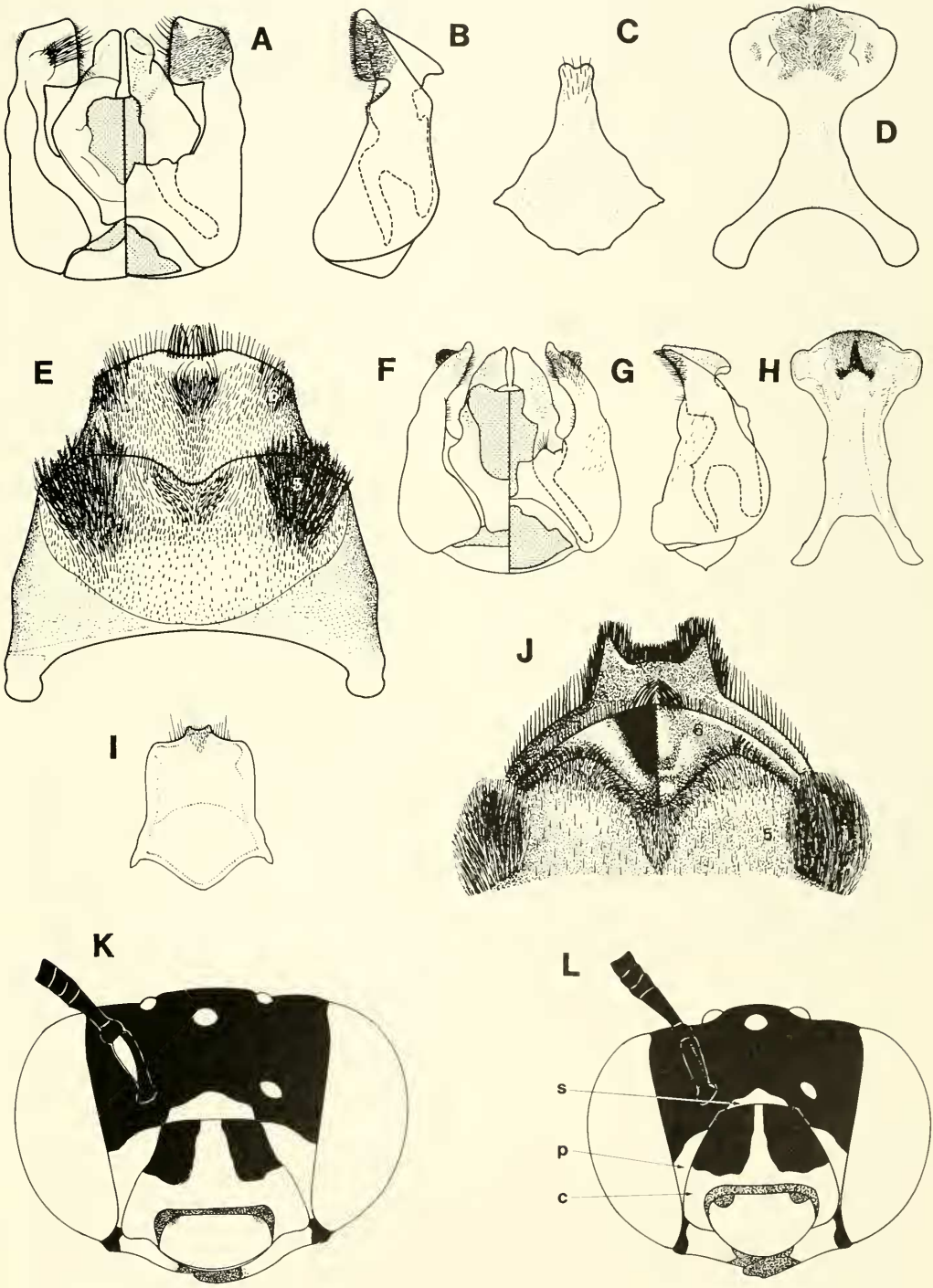
Micramegilla new subgenus

Type species: *Anthophora niveata* Friese, 1905.

Diagnosis. Length 9-18 mm; S7 of male medioapically entire with a dense patch of hair and without lateral, subapical, lightly sclerotized, circular area (see *Description*) (Fig. 37h); S8 of male medioapically bilobed, lobes small and close together, apex of S8 wide (Fig. 37i); gonocoxite of male apically simple and dorsoventrally flattened (Figs. 37f, g); gonostylus absent; paraocular marks absent in female (except in *A. atrocincta* see *Comments*).

Description. a. Length 9-18 mm. b. Flagellar segment 1 of female equal to length of next 2.5-3.0 segments together, of male equal to length of next 1.1-1.6 segments. c. Mentum .7 as long as prementum; paraglossa about as long as stipes; galea in repose at most attaining anterior edge of midcoxa; maxillary palpus 5- or 6-segmented; labial palpus 4-segmented; face with white to yellow markings, paraocular marks present to absent in male and absent in female (except in *A. atrocincta*); wings clear (infuscated in *godofredi*). d. Basitibial plate of male present or absent. e. S6 of male apicomedially shallowly emarginate (except *mucorea* entire). f. S7 of male usually broadly, shallowly emarginate (except *godofredi* and *niveata* entire and rounded, *maclachlani* entire and acute); apicolateral margin with rounded lobe; lateral margin with weak tooth in basal half to third (weakly developed in *godofredi,* straight in *maclachlani*); disc with longitudinal sclerotization; length of apodeme .32-.43 length of disc (Fig. 37h). g. S8 of male with broad apex, apicomedially bilobed; apicolateral margin rounded; lateral margin more or less straight to base of apodeme; longitudinal sclerotization absent (Fig. 37i). h. T7 of male apicomedially bilobed (some-

FIG. 37. *Amegilla,* subgenera *Zonamegilla* and *Micramegilla.* A-E, *A. (Z.) zonata* male; F-I, *A. (M.) niveata* male; J, *A. (Z.) andrewsi* male; K, *A. (Z.) niveocincta* female; L, *A. (Z.) quadrata* female. c = clypeal mark, p = paraocular mark, s = supraclypeal mark. Numbers refer to the metasomal sterna. A, B, Genital capsule, dorsoventral and side views. C-E, S8-S6, ventral views. F, G, Genital capsule, dorsoventral and side views. H, I, S7 and S8 ventral views. J, S5, S6, and T7, ventral views. K, L, Head.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times with weak median lobe) and occasionally shelf-like (i.e., *mucorea*). i. Gonocoxite of male apically simple dorsoventrally flattened (Fig. 37f, g). j. Gonostylus of male absent. k. Apex of penis valve 1.8-2.3 times as long as wide viewed apicodorsally, setae small and scattered. l. Bridge of penis valves 1.1-2.8 times as long as wide, basally entire (weakly emarginate in *nivescens,* broadly so in *maclachlani*).

Etymology. Mikros (Gr.), small, little, plus *Amegilla,* referring to the small size of many species in this group.

Comments. Micramegilla is most closely related to *Ackmonopsis* and *Aframegilla.* It is easily separated from *Ackmonopsis* by having apical bands and/or appressed hair on the metasoma. It is separated from *Aframegilla* by having non-metallic hair and no gonostylus in the male. *Micramegilla* resembles *Zebramegilla* from which it can be differentiated, along with *Ackmonopsis* and *Aframegilla,* by the shape of the male S8 which is somewhat quadrate with two small submedian apical lobes and by the male S7 which has a single rounded apicolateral lobe and short apodeme.

Many species are small, resembling *Heliophila,* having complete apical bands and/or appressed hair on the visible portions of the metasomal terga. *A. godofredi* is a striking species from the Cape Verde Islands. It is essentially all black with an apical band of pale hair on T1 and hair on the legs bright orange. *A. atrocincta* is also a non-typical member of *Micramegilla,* being a large yellow-haired bee with T1, T2 (except apical margin of T2), and legs all black.

Biology. The adults in subsaharan Africa fly from September to April. In the Middle and Far East they fly from April to September.

Included Species. A. (Micramegilla) andresi (Friese) new combination, *atrocincta* (Lepeletier) new combination, *byssina* (Klug) new combination, *canifronoides* n. sp., *capeverdensis* n. sp., *fasciata* (Fabricius) new combination, *godofredi* (Dours) new combination, *latizona* (Spinola) new combination, *maclachlani* (Fedtschenko), *modestoides* n. sp., *montivaga* (Fedtschenko), *mucorea* (Klug) new combination, *nigricornis* (Morawitz), *niveata* (Friese), *nivescens* (Cockerell) new combination, *velutina* (Friese), and *velocissima* (Fedtschenko). The distribution of this group extends from southern, central and eastern Africa (including the Cape Verde Islands) to the Mediterranean region of Europe and eastward to northern India.

Subgenus *Zonamegilla* Popov

Zonamegilla Popov, 1950, p. 260.

Type species: *Apis zonata* Linnaeus, 1758. Original designation.

Diagnosis. Australia to southeast China and India; length 10-14 mm; most species with metallic blue or green hair, or occasionally metallic orange, on metasomal terga (see *Description);* S5 of male apicomedially broadly to narrowly emarginate (Figs. 37e, j) (except the Indian *A. calceifera,* entire); S6 of male with deep lateral concavity on apical third, median longitudinal Y-shaped ridge on apical third, sometimes with median protuberance, tuft of black hair apicomedially or on protuberance, apex of apodeme simple without lateral projection (Figs. 37 e, j); S8 of male apically bilobed, narrowed (Fig. 37c); apex of gonocoxite triangular as viewed ventrally [except the Chinese *zonata,* quadrate (Fig. 37a)], bent inward; gonostylus of male reduced to blister or knob (see *Description,* character j).

Description. a. Length 10-14 mm. b. Flagellar segment 1 of female equal to length of next 2.3-2.8 segments together, of male equal to length of next 1.2-1.8 segments together. c. Mentum about .7 as long as prementum; paraglossa about as long as stipes; galea in repose attaining middle of midcoxa to anterior edge of hind coxa; maxillary palpus with 6 segments; labial palpus with 4 segments; face with white to yellow markings, paraocular marks present in male and female; wing infuscated to clear. d. Basitibial plate present in male. e. S6 of male on apical third of disc, with deep lateral concavity, median Y-shaped ridge between the two concavities, and patch of black hair apicomedially (Fig. 37j); apical margin entire, rounded (with apicomedian shallow emargination in *A. puttalama, walkeri,* and *zonata*), apex of apodeme simple, without lateral projection (Fig. 37e); S5 of male apicomedially broadly emarginate (Figs. 37e, j) (entire in Indian *calceifera*). f. Apex of S7 of male entire and rounded, occasionally apicomedially acute, laterally with subapical carina and circular area present; lateral margin without tooth on basal half (weak tooth present in *niveocincta*); longitudinal sclerotization present; length of apodeme .4-.5 length of disc (Fig. 37d). g. S8 of male apically narrow, bilobed; lateral margin on apical third converging distally (Fig. 37c). h. T7 of male apicomedially shelf-like, bilobed, apical margin between lobes entire (Fig. 37j) (rounded in *samarensis* and weakly emarginate in *walkeri*); hair on metasomal terga metallic blue or green (most species), metallic orange (a few species), or non-metallic orange (*dohertyi* from Timor) or all white (*niveocincta* from India). i. Apex of gonocoxite of male dorsoventrally flattened, triangular in ventral aspect [except *zonata* quadrate (Fig. 37a)] and bent inward. j. Gonostylus of male present (absent in Indian *niveocincta*), reduced to blister (in *calceifera* gonostylus as long as broad), with 4-8 setae (Fig. 37a). k. Apex of penis valve twice as long as broad (2.7 times as long as broad in *calceifera*) as viewed apicodorsally, with small scattered setae. l. Bridge of penis valves 0.9-2.0 times as long as wide, broadly emarginate basally.

Comments. Zonamegilla is most closely related to *Asaropoda* and *Notomegilla.* They are separated from *Asaropoda* by usually having an inverted T-shaped clypeal mark, having metallic metasomal hair, having a greatly reduced male gonostylus

and having a much more apically narrowed male S8. *Zonamegilla* differs from *Notomegilla* by having apically strongly emarginate S5 and S6 in the males, lacking a tooth on the apodeme of the male S7 and having the male S8 basally simple rather than bilobed. In addition, *Notomegilla* is restricted to Australia and *Asaropoda* to Australia, New Guinea and the Bismarck Archipelago.

Parts of *Zonamegilla* have been treated by Dover (Oriental — 1924), Rayment (Australia — 1939, 1944 [not 1942], 1947) and Lieftinck (Korea — 1975). Some of the Rayment species are probably synonyms but are listed below pending a revisional study.

Traditionally *Zonamegilla* have been referred to as the "blue banded bees" (Rayment, 1935) since almost all members have blue or green metallic hair in apical bands on the metasomal terga.

Biology. Michener (1960) described the nesting biology of *A. salteri.* Cardale (1968a-c) described the nesting biology, the larva, and associated parasites and predators of *pulchra.* The species fly year around.

Included Species. A. (Zonamegilla) adelaidae (Cockerell), *andrewsi* (Cockerell) new combination, *asserta* (Cockerell), *atripes* (Friese) new combination, *atrocaerulea* (Dours) new combination, *australis* (Rayment), *berylae* (Rayment), *binghami* (Schulz) new combination, *borneensis* (Cockerell) new combination, *buruensis* (Cockerell), *calceifera* (Cockerell) new combination, *cinctofemorata* (Dours), *cingulata* (Fabricius), *cingulifera* (Cockerell) new combination, *comberi* (Cockerell) new combination, *custos* (Dalla Torre) new combination, *dohertyi* (Gribodo) new combination, *dulcifera* (Cockerell), *elegans* (Smith), *fabriciana* (Rayment), *ferrisi* (Rayment), *flammeozonata* (Dours) new combination, *hackeri* (Rayment), *holmesi* (Rayment), *insignita* Brooks, *korotonensis* (Cockerell) new combination, *longmani* (Rayment), *longula* (Rayment), *mimica* (Rayment), *murrayensis* (Rayment), *niveocincta* (Smith) new combination, *parapulchra* (Rayment), *parhypate* Lieftinck, *perasserta* (Rayment), *perpulchra* (Rayment), *pulchra* (Smith), *puttalama* (Strand) new combination, *salteri* (Cockerell), *samarensis* (Cockerell) new combination, *sapiens* (Cockerell), *shafferyella* (Rayment), *stantoni* (Cockerell), *subsalteri* (Rayment), *ternatensis* (Cockerell) new combination, *thorogoodi* (Rayment), *vegeta* (Bingham) new combination, *walkeri* (Cockerell), *wallacei* (Cockerell), *whiteheadi* (Cockerell) new combination, *whiteleyella* (Rayment) and *zonata* (Linnaeus). *Zonamegilla* range from Australia (absent from Tasmania) to southeast China and India.

Notomegilla new subgenus

Type species: *Anthophora aeruginosa* Smith, 1854.

Diagnosis. Australian; length 9-12 mm; hair having a metallic green tint (sometimes only visible under a microscope; except male of *A. chlorocyanea* with white hair); S6 of male simple, convex without lateral depression, margin entire to shallowly emarginate medially; apex of S7 of male greatly expanded laterally suggesting *Ackmonopsis,* without lateral subapical circular area (Fig. 38d); apex of S8 of male narrowed, truncate or rounded, similar to that of *Amegilla* s. str. (Fig. 38c); apex of gonocoxite of male dorsoventrally flattened, bent inward and apicoventrally (Figs. 38a, b); gonostylus of male absent; maxillary palpus with 4 segments (*chlorocyanea* with 5).

Description. a. Length 9-12 mm. b. Flagellar segment 1 of female equal to length of next 3.0-3.1 segments together, of male equal to length of next 1.2-1.9 segments together. c. Mentum .7 as long as prementum; paraglossa about .8 as long as stipes; galea in repose attaining anterior edge of midcoxa or slightly less; maxillary palpus with 4 segments (5 in *A. chlorocyanea*); labial palpus with 4 segments; face with white or yellow markings, paraocular marks of male and female well developed; wings clear. d. Basitibial plate present in male. e. S6 of male simple, without lateral depression, apically entire to shallowly emarginate medially. f. Apex of S7 of male greatly expanded laterally as in *Ackmonopsis,* entire and rounded to flat medially, with dense transverse patch of hair, sometimes with median subapical protuberance; apicolaterally weakly bilobed with small upper lobe and large outer lobe or with only large outer lobe present, outer lobe sometimes with transverse carina mostly paralleling margin on distal half; lateral margin with tooth on basal half (*aeruginosa* in addition has tooth on basal third); lateral subapical circular area absent; longitudinal sclerotization present; length of apodome .38-.67 length of disc (Fig. 38d). g. Apex of S8 of male narrowed, either round or truncate; lateral margin on apical half converging distally (Fig. 38c). h. T7 of male apicomedially with two teeth, apical margin between teeth straight. i. Apex of gonocoxite of male dorsoventrally flattened, bent inward and then basally [*aeruginosa* also with apex laterally expanded on basally directed apex (Figs. 38a, b)]. j. Gonostylus of male absent; ventral lobe of gonocoxite of male present. k. Apex of penis valve 1.8-2.1 times as long as wide, subapically constricted, as viewed apicodorsally, with small and scattered setae. l. Bridge of penis valves 1.0-1.5 times as long as wide, broadly emarginate basally, not constricted but lateral margin round (Fig. 38a).

Etymology. Notos (Gr.), south, plus *Megilla,* a name of a related taxon. The name *Notomegilla* refers to the Australian distribution of this subgenus.

Comments. Notomegilla is closely related to *Zonamegilla* and *Asaropoda.* It is separated from these two by the light green metallic hair (not blue or bright green), the expanded apex of male S7 with a tooth on the apodeme and the apex of the male S8 more or less simple.

Some of the Rayment species are probably synonyms but are included below pending revisional study.

Included Species. A. (Notomegilla) adamsella (Rayment), *aeruginosa* (Smith), *chlorocyanea* (Cockerell), *grayella* (Rayment), *jamesi* (Rayment), *mewiella* (Rayment, *murrayi* (Rayment), and *sybilae* (Rayment). *Notomegilla* is endemic to Australia.

Glossamegilla new subgenus

Type species: *Anthophora mesopyrrha* Cockerell, 1930.

Diagnosis. Length 13-20 mm; pubescence brown (see *Comments*), thoracic hair short, dense, velvety, metasomal hair appressed, covering tergal discs evenly or only apically as bands; apex of S7 of male entire (broadly emarginate in the Indian *A. pseudobomboides*), rounded, apicolateral margin with one to two lobes (Fig. 38e); apex of S8 of male broad, bluntly bilobed, lateral margins slightly diverging to slightly converging distally (Fig. 38f); inner margin of gonocoxite of male with a rounded lobe (absent in *lieftincki*), apical lobe blunt (acute in *malaccensis*), gonocoxite of male not expanded apically (Figs. 38g, h); gonostylus of male absent.

Description. a. Length 13-20 mm. b. Flagellar segment 1 of female equal to length of next 2.7-3.5 segments together, of male equal to length of next 1.3-2.6 segments together. c. Mentum 0.7-1.0 as long as prementum; paraglossa 1.0-1.2 as long as stipes; galea in repose attaining middle of midcoxa to posterior edge of hind coxa; flabellum elongate and very narrow, often apically entire (e.g., *A. pseudobomboides*), if not with numerous short finger-like lobes; maxillary palpus with 6 segments; labial palpus with 4 segments; face with white to yellow markings (reddish-yellow in *himalajensis*), paraocular marks present in male and female (absent in females of *violacea* and *pseudobomboides*); wings infuscated. d. Basitibial plate present in male. e. S6 of male with shallow, apicomedial emargination (occasionally entire). f. Apex of S7 of male entire, round (except broadly emarginate in *pseudobomboides*), without lateral subapical circular area (except in *pseudobomboides*), often with lateral, subapical, transverse carina and with median, longitudinal ridge on apical third; apicolateral margin rounded, with one sometimes two lobes, rarely with one angulate lobe; lateral margin with tooth on basal half; longitudinal sclerotization present; length of apodeme .27-.44 length of disc (Fig. 38e). g. Apex of S8 of male broad, broadly emarginate; lateral margins slightly diverging to slightly converging distally; longitudinal sclerotization sometimes present (Fig. 38f). h. T7 of male apicomedially with two teeth, sometimes shelf-like between bases of teeth, apical margin between teeth straight to very slightly rounded; pubescence brown except in a few non-typically colored species discussed in *Comments*. i. Apex of gonocoxite of male usually blunt (acute in *malac-*

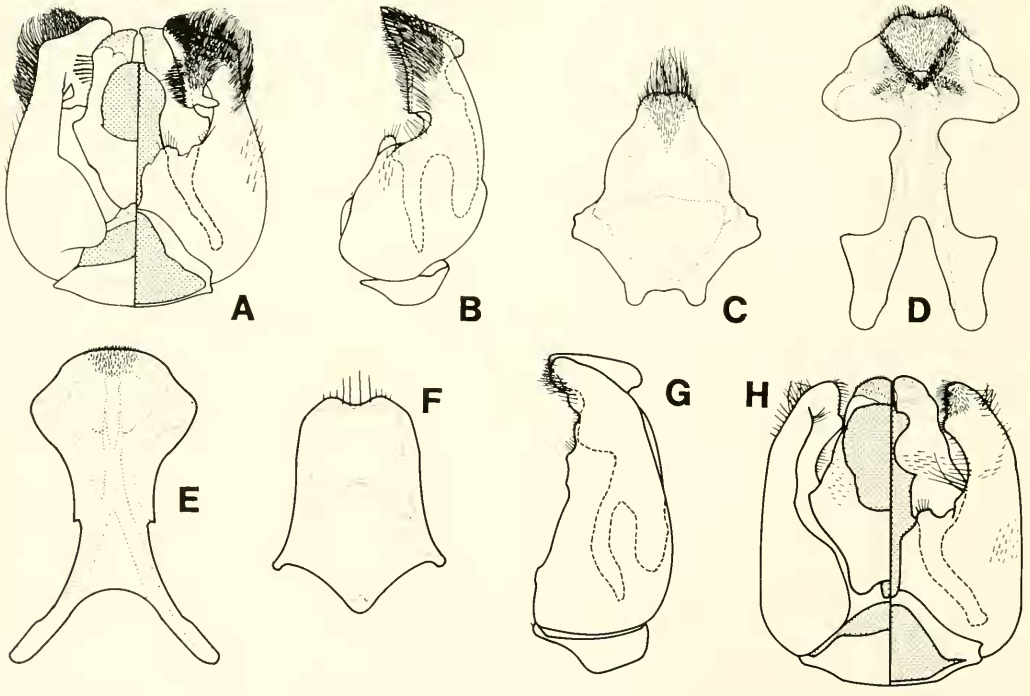

FIG. 38. *Amegilla* subgenera *Notomegilla* and *Glossamegilla*. A-D, *A. (N.) aeruginosa*, male; E-H, *A. (G.) mesopyrrha*, male. A, B, Genital capsule, dorsoventral and side views. C, D, S8 and S7, ventral views. E, F, S7 and S8, ventral views. G, H, Genital capsule, side and dorsoventral views.

censis), inner margin with one or two lobes (Figs. 38g, h). j. Gonostylus of male absent. k. Apex of penis valve 1.5-2.2 times as long as broad, with small scattered setae. l. Bridge of penis valves 0.8-1.5 times as long as wide, shallowly to deeply and broadly emarginate basally.

Etymology. *Glossa* (Gr.) tongue, plus *Amegilla.* The name *Glossamegilla* refers to the long tongues characteristic of the bees of this subgenus.

Comments. The relationship of *Glossamegilla* to the other subgenera of *Amegilla* remains uncertain. It seems to be closest to *Micramegilla. Glossamegilla* can be recognized by the following combination of characters: the usually brown appressed pubescence on the metasomal terga, S7 of the male wide apically with two blunt apical lobes and the apex of the gonocoxite of the male with one or two lobes. Besides the brown coloration, these bees have short, velvety thoracic and appressed metasomal pubescence and have long tongues, attaining as much as 11 mm for the galea and 23 mm for the glossa.

A. violacea is essentially all black with patches of white hair along the lateral margins of the metasomal terga, *fimbriata* has white and black hair intermixed on the thorax and a black metasoma with small lateral white patches of hair, and *pseudobomboides* is probably a bumble bee mimic having a yellow thorax, a black scutum and the metasoma all orange (male) or T1-T2 yellow, basal half of T3 black, apical half of T3 and subsequent terga orange (female).

Lieftinck (1944, 1956) described some new species, redescribed many others, and gave a key to the Malaysian members of *Glossamegilla*

Biology. The adults fly from May to March.

Included Species. A. (Glossamegilla) amymone (Bingham) new combination, *bouwmani* (Lieftinck), *brookiae* (Bingham) new combination, *cinnyris* (Lieftinck) new combination, *cyrtandrae* (Lieftinck), *elephas* (Lieftinck) new combination, *feronia* (Lieftinck) new combination, *fimbriata* (Smith) new combination, *florea* (Smith), *gigas* (Friese), *hanitschi* (Meade-Waldo) new combination, *himalajensis* (Radoszkowsky) new combination, *insularis* (Smith) new combination, *jacobi* (Lieftinck) new combination, *lieftincki* n. sp., *luzonica* (Cockerell) new combination, *malaccensis* (Friese) new combination, *mesopyrrha* (Cockerell), *pagdeni* Lieftinck, *pendleburyi* (Cockerell) new combination, *proboscidea* Lieftinck, *pseudobomboides* (Meade-Waldo) new combination, *subinsularis* (Strand) new combination, *subrussata* (Cockerell) new combination, *sumatrana* Lieftinck, *urens* (Cockerell) new combination, *vigilans* (Smith) new combination, *violacea* (Lepeletier) and *yunnanensis* Wu. *Glossamegilla* is distributed from India to southeast Asia into the Indomalaysian area where most of the species diversity is found.

Subgenus *Asaropoda* Cockerell

Asaropoda Cockerell, 1926, p. 216.

Type species: *Saropoda bombiformis* Smith, 1854. Original designation.

Diagnosis. Australian species (including New Guinea and the Bismarck Archipelago); length 13-24 mm; pubescence brown to gray (mostly black in *A. aurata* from New Guinea and the Bismarck Archipelago); maxillary palpus with 5 segments (see *Description*); apical margins of male metasomal sterna modified, S4 usually produced medially, rounded and having a thick brush of hair (hair omitted from Fig.) (Fig. 39a), S5 broadly and deeply emarginate (Fig. 39a), S6 shallowly emarginate medially with one to two dense patches of hair laterally (hair omitted from Fig.); S7 apically somewhat quadrate, medioapically emarginate (Fig. 39f); S8 apically narrowed (Fig. 39c); apex of gonocoxite of male bilobed with long, narrow, upper lobe and small ventral lobe (Figs. 39b, g); gonostylus of male well developed (Fig. 39b).

Description. a. Length 13-24 mm. b. Flagellar segment 1 of female about equal to length of next 2.8-3.1 segments together, of male equal to length of next 1.3-2.0 segments together. c. Mentum .6-.7 as long as prementum; paraglossa 0.7-1.1 as long as stipes; galea in repose attaining anterior edge of forecoxa to anterior edge of midcoxa; maxillary palpus with 5 segments (sixth is fused to fifth segment) (*A. aurata* from Bismarck Archipelago occasionally has 6); labial palpus with 4 segments; face with yellow to reddish-yellow markings, paraocular marks present in male (Fig. 39e), absent in female (Fig. 39d); wings clear to infuscated. d. Basitibial plate present in male. e. Apical margins of male S4-S6 modified, S4 with median tenth produced, rounded, with dense patch of black to reddish-brown hair, S5 with deep, broad median emargination and with 1 or 2 dense patches of hair laterally, S6 apically flexed ventrad with shallow, median emargination and median, longitudinal, rounded ridge on apical sixth of disc, laterally with dense patch of red-brown hair (hair omitted from drawing) (Fig. 39a). f. Apex of S7 of male somewhat quadrate, apicomedially entire or with small, shallow emargination, apicolateral margin rounded, lateral subapical carina often present, circular area absent, often with median longitudinal ridge on apical half; lateral margin with tooth on basal half, longitudinal sclerotization present; length of apodeme .41-.46 length of disc (Fig. 39f). g. S8 of male apically narrow, bilobed; lateral margins of apical fourth to half converging distally, margin angulate or straight (Fig. 39c); S8 basally more or less rounded (except *dawsoni* basally trilobed with lobes basally directed). h. Apex of T7 of male apicomedially with 2 widely separated teeth (except *dawsoni* shelf-like without teeth), apical margin between teeth straight (Fig. 39a). i. Apex of gonocoxite of male not dorsoventrally flattened but bilobed, with large, apical, elongate upper lobe and small blunt to acute, ventral lobe as viewed ventrally (Fig. 39b), in profile bilobed (Fig. 39g). j. Gonostylus of male present, well developed, 3-10 times as long as wide. k. Apex of

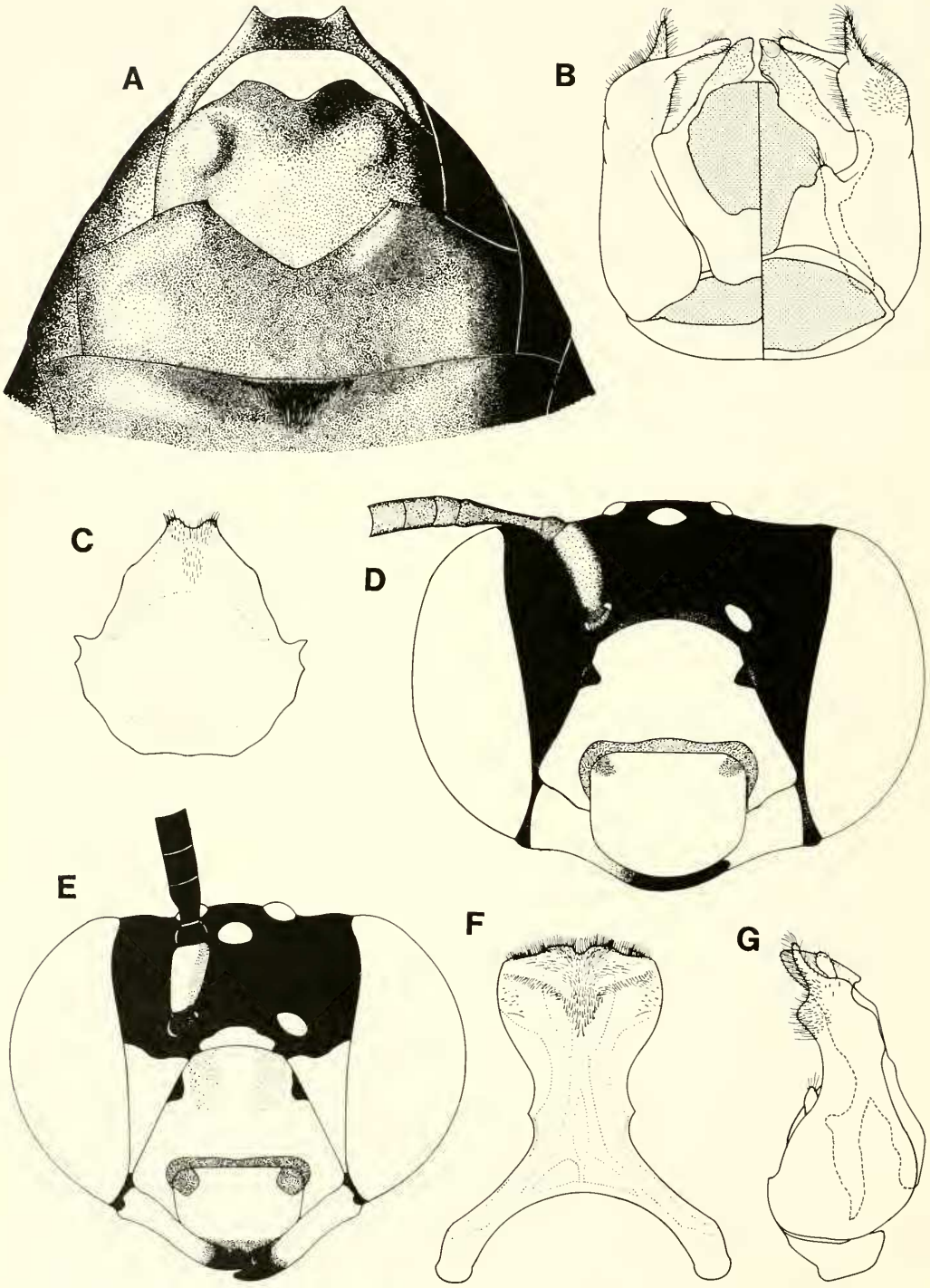

FIG. 39. *Amegilla (Asaropoda) bombiformis.* A-C, male; D, female; E-G, male. A, Apex of metasoma showing principally S5-S6 and T7 (hair omitted), ventral view. B, Genital capsule, dorsoventral view. C, S8, ventral view. D, E, Head. F, S7, ventral view. G, Genital capsule, side view.

penis valve 1.8-2.2 times as long as broad as viewed apicodorsally, with small scattered setae. l. Bridge of penis valves 0.6-1.6 times as long as wide, broadly emarginate basally.

Comments. Asaropoda is most closely related to *Zonamegilla* and *Notomegilla.* It is separated from the former by the lack of metallic hair, the presence of a well developed male gonostylus, the pale clypeus and characters of the male S7, S8 and genital capsule given in the *Comments* on *Zonamegilla.* It is separated from *Notomegilla* by the larger size, brown or gray pubescence, somewhat quadrate apex of the male S7 and presence of a well developed male gonostylus.

This group of bees has been given generic status by some authors (Cockerell, 1926; Cockerell, 1931b; Rayment, 1951), but is clearly only of subgeneric import considering many of the derived characters it shares with all other subgenera of *Amegilla.* Rayment (1951) treated the species of *Asaropoda* briefly, describing six new species but giving no key to species or good diagnostic characters for the group. Some of the Rayment species are probably synonyms but are included below pending a revisionary study. There are several species, both described and undescribed, which look superficially like *A. bombiformis.*

Traditional characters for *Asaropoda* have been the red-brown coloration and loss of the last two segments of the labial palpus, but it appears that these segments are easily broken off and in life there are four segments. Michener (1965) defined *Asaropoda* more clearly and recognized its affinity within *Amegilla,* giving it subgeneric status and building upon the work of Rayment (1951).

Biology. This group of bees flies year around. There is an apparent absence of *Asaropoda* from the dry interior of Australia, but this may be from lack of sufficient sampling.

In *Anthophora* turret-making is found only in species of the subgenus *Melea;* in *Amegilla* it is characteristic only of some species of the subgenus *Asaropoda.* A single female of *A. rickae* from Bolgart, Western Australia (Rayment, 1951) and a big aggregation of *dawsoni* from 160 miles (258 km) northeast of Carnavon, W. Australia (Michener, 1965) both were found with turrets over their nest burrows. Cardale (1968b-d) gave some biological notes about an unidentified species of *Asaropoda* and described its larva (Cardale, 1968c).

Included Species. A. (Asaropoda) albiceps (Rayment), *albigenella* Michener, *alpha* (Cockerell), *anomala* (Cockerell), *aurata* (Friese) new combination, *bombiformis* (Smith), *calva* (Rayment), *cygni* (Rayment), *dawsoni* (Rayment), *dentiventris* (Rayment), *epaphrodita* n. sp., *grisescens* (Rayment), *houstoni* n. sp., *imitata* (Rayment), *meltonensis* (Rayment), *preissi* (Cockerell), *punctata* (Rayment), *rhodoscymna* (Cockerell), *rickae* (Rayment), *rubricata* (Rayment), *rufa* (Rayment), *rufescens* (Friese), *scymna* (Gribodo), *sordida* (Rayment), *sordidula* (Rayment), and *victoriensis* (Rayment). This group is Australian (including New Guinea and the Bismarck Archipelago but not Tasmania).

Amegilla incertae sedis

The following species of *Amegilla* cannot be placed with certainty into a subgenus because the males are unknown, the types are lost, destroyed or have not been studied yet: *A. advenula* (Cockerell) new combination, *annos* (Vachal) new combination, *aspergina* (Cockerell), *atriceps* (Radoszkowsky), *bucharica* (Gussakovsky), *caffra* (Friese) new combination, *caldwelli* (Cockerell), *camelorum* (Cockerell), *cana* (Walker) new combination, *candens* (Pérez), *candida* (Smith) new combination, *candidella* (Priesner), *centralis* (Cockerell) new combination, *deltoides* (Buysson) new combination, *expleta* (Vachal) new combination, *glycyrrhizae* (Gussakovsky), *gussakovskyi* (Popov), *hypocyanea* (Cockerell) new combination, *karakumensis* (Gussakovsky) new combination, *katangensis (Cockerell) new combination, liberica* (Cockerell) new combination, *lutulenta* (Klug), *macroleuca* (Cockerell), *maculicornis* (Lepeletier) new combination, *marqueti* (Pérez), *mephistophelicana* (Strand) new combination, *nigropilosa* (Friese) new combination, *nivea* (Lepeletier) new combination, *nonconforma* n. sp., *potanini* (Morawitz) new combination, *pulverea* (Walker) new combination, *rapida* (Smith) new combination, *ruficornis* (Dours) new combination, *rufipes* (Lepeletier) new combination, *semipulverosa* (Dours), *senegalensis* (Friese) new combination, *simbana* (Cockerell) new combination, *sjoestedti* (Friese) new combination, *subtorrida* (Cockerell) new combination, *torensis* (Priesner) new combination, *tubifera* (Cockerell) new combination and *vestitula* (Cockerell) new combination.

CLADISTIC ANALYSIS

Using a list of variables for which polarity could be determined with reasonable confidence, I have developed a list (Table 1) of 70 apomorphous tribal, generic and subgeneric characters found in the tribes Anthophorini and Habropodini, the genera *Anthophora* and *Amegilla* and the subgenera of *Anthophora.* A similarly constructed list (Table 3) of 17 apomorphic characters was compiled for the subgenera of *Amegilla.* The distribution of these characters among the taxa, i.e., the data on which the cladograms are based, are given in Tables 2 and 4 respectively. Cladistic methodology is discussed in the section on Methods. Because decisions on what taxa to recognize were made after the cladistic analysis, some species groups, not now recognized as taxa, were included as separate entities in the study. Table 1 therefore includes some characters relevant to those groups but not used as subgeneric characters.

TABLE 1. LIST OF VARIABLES OF SUBGENERA OF *ANTHOPHORA* AND THE TRIBES ANTHOPHORINI AND HABROPODINI.

For each variable (1-70) a synapomorphous state is coded as (1). A state of (2) or more is a further derivation of synapomorphous state number (1). Plesiomorphous states are listed in brackets and coded as 0. 1-59 are variables useful within *Anthophora,* variables 60-70 concern the tribes Anthophorini and Habropodini.

1. Flagellar segment 1 of female equal to total length of more than four succeeding segments (Fig. 7a) (2). Flagellar segment 1 of female equal to total length of more than three to four succeeding segments (1). [Flagellar segment 1 of female equal to total length of three or fewer succeeding segments (Fig. 7b).] Habropodine, eucerine, melitomine and exomalopsine bees all have a relatively short first flagellomere which is therefore considered the plesiomorphic state.

2. Face of male with white markings (1). [Face of male with yellow markings.] Almost all non-parasitic Anthophoridae, as well as most bees which have pale-faced males, have yellow facial markings on the males.

3. Face of female with pale integumental marking on clypeus (1). [Face of female black.] A female with integumental facial marking is rare in the Anthophorinae except in the Anthophorini. Only a few species of habropodines have such markings. Among the exomalopsine bees facial markings in females are unknown, and presumably this is the plesiomorphous state. Pale facial markings are found in almost all females of *Amegilla* and *Anthophora (Heliophila).* This character has independently arisen in various subgenera of *Anthophora.*

4. Pale paraocular mark of male absent (1). [Pale paraocular mark of male present.] The polarity of this variable is uncertain since many exomalopsine males, all male melitomines and almost all male eucerines have black paraocular areas. Almost all habropodine and anthophorine males, however, have pale paraocular marks. It seems that all species that have males with black faces have close relatives which have the pale paraocular marks. Therefore, the apomorphous state within the Anthophorini seems to be loss of the pale paraocular marks.

5. Pale paraocular marks in female present (1). [Pale paraocular marks in female absent.] There are almost no females in the Anthophorinae with pale paraocular marks except for *Amegilla* (a few *Amegilla* have lost these marks). Therefore the presence of these marks presumably is an apomorphy.

6. Face of female flattened, clypeus with erect, apically hooked or wavy setae and often basally with a pecten, that is, a transverse row of stout erect flattened bristles (Fig. 17b) (1). [Face of female moderately to strongly protuberant with unspecialized, gently curved setae.] In the Anthophorini this synapomorphy is unique to *Mystacanthophora* (most species). This distinctive derived condition is also found in *Amegilla paradoxa* n. sp., in two species of *Habropoda,* in many species of *Deltoptila,* in *Trachusa (Ulanthidium),* an undescribed subgenus of South American *Megachile* (Moure pers. comm.), *Pectinapis,* two species of *Andrena* and one species of *Xenoglossodes.* This widespread phenomenon is possibly linked to some foraging adaptation.

7. Labrum of male apically trilobed (Fig. 25i). [Labrum of male apically entire.] The apically trilobed labrum has independently arisen at least twice in the Anthophorini but is not found in other Anthophorinae.

8. Labrum of female with median subapical bituberculate projection (Fig. 32a). [Labrum of female simple.] A synapomorphy of a group of African *Heliophila.*

9. Malar space of female strongly elongate, less than three times wider than long (2). Malar space of female wide, three times wider than long (1). [Malar space of female linear, five or more times wider than long.] The elongation of the malar space to provide space for the increased length of the mouthparts is an obvious apomorphy found only in some *Melea,* all *Rhinomegilla* and *Anthomegilla* in the Anthophorini.

10. Mandible of male simple (1). [Mandible of male with subapical tooth.] This is an apomorphy of some *Heliophila,* other Anthophorini and Habropodini have males with an upper mandibular tooth.

11. Mandible tridentate, with upper and lower subapical teeth (1). [Mandible bidentate, without lower subapical tooth.] The tridentate mandible is unique to *Clisodon* and is an adaptation to nesting in wood.

12. Flabellum apically simple, elliptical as viewed from in front (1). [Flabellum with apical margin deeply and numerously lobed or simple or as in variables 13 and 14.] The apomorphy is unique to *Anthophora* s. str.

13. Flabellum apically simple, apical two-thirds narrowed and parallel sided (Fig. 25d) (1). [Flabellum apically with several long finger-like lobes.] This is an unique apomorphy of *Anthomegilla.*

14. Flabellum long, with numerous small lobes on apical margin (Fig. 26b) (1). [Flabellum with apical margin deeply lobed or simple.] This autapomorphy is found only in *Rhinomegilla.*

15. Galea with a "double chambered lumen" (Fig. 5c) (1). [Galea with a single narrow lumen (Fig. 5b).] Melitomine, eucerine and centridine bees all have a single narrow galeal lumen. The "double chambered lumen" is unique to *Amegilla.*

16. Sixth segment of maxillary palpus equal to about half length of fifth (1). [Sixth segment of maxillary palpus about equal to length of fifth.] Among those tribes of the Anthophorinae which have a six-segmented maxillary palpus such as exomalopsine, melitomine and habropodine bees, the sixth is about equal in length to the fifth as it is in *Anthophora*. *Amegilla* has a reduced sixth segment, an apomorphy.

17. Basistipital process bilobed (Figs. 25a, 25e, 25f) (1). [Basistipital process with one projection (Fig. 5d).] Habropodine, centridine, eucerine and melitomine bees have a basistipital process with one projection. *Anthophora* has a secondary projection on the process.

18. Scape anteriorly with dense pilosity such that integumental surface is hidden (1). [Scape with pilosity anteriorly sparse to absent.] The derived condition is found only in some *Heliophila*.

19. Mentum with long anterior tooth near basal third (Fig. 22k) (1). [Mentum simple (with single, short tooth only in *A. (Dasymegilla) excisa)* near basal third.] This strong synapomorphy unites *Melea* and *Anthophoroides*.

20. S7 of male as wide as long, rather square in ventral aspect, sides almost equal in length and lateral margins almost parallel (Fig. 18d) (1). [S7 of male not square in ventral aspect, width less than length, lateral margins converging apically.] This apomorphy is found only in *Caranthophora*.

21. Midtarsal brush of male present (Fig. 2h) (1). [Midtarsal brush of male absent.] This apomorphic character is found almost exclusively in *Pyganthophora* and its relatives; except for a few other species of *Anthophora,* it is unknown in other Anthophoridae.

22. Midbasitarsal brush of male present (Fig. 29b) (1). [Midbasitarsal brush of male absent.] See comments on character 21, except this has independently evolved in *Caranthophora*.

23. Middistitarsal brush of male present (Fig. 2h) (1). [Middistitarsal brush of male absent.] See comments on character 22.

24. Hind basitarsus of male modified with tooth and/or ridge (1). [Hind basitarsus of male simple.] Most *Anthophora* and all *Amegilla* males have simple hind basitarsi. This modification of the hind basitarsus apparently has arisen once in the Anthophorini and is an apomorphy.

25. Basitibial plate of female pointed apically (Fig. 29b) (1). [Basitibial plate of female apically rounded.] This is a unique character found in *Clisodon*.

26. Basitibial plate of male poorly defined to absent (1). [Basitibial plate of male present, well defined.] Presumably the genetic expression in the female to produce a basitibial plate is carried over and expressed in the male. Though the polarity of this character is uncertain, I believe that the loss of the basitibial plate in the male is an apomorphy.

27. Hind tibia of female with posterior margin with simple hairs (Fig. 22h) (1). [Hind tibia of female with posterior margin with plumose hairs.] This character is unique to three small groups of *Anthophora*. The remaining *Anthophora,* all *Amegilla* and Habropodini have plumose posterior zones of hair on their hind tibiae and thus the simple hair in this zone probably is an apomorphy.

28. Hind femur and tibia of female with white appressed plumose hairs almost completely obscuring outer surfaces (Fig. 32l) (1). [Hind femur and tibia of female without appressed plumose hairs on outer surfaces.] This apomorphy is unique to some *Heliophila*.

29. Hind basitarsus of female with posterior distal process acute (Fig. 22h) (1). [Hind basitarsus of female with posterior distal process rounded.] This is an autapomorphy of *Melea*.

30. Apex of hind tibia of male with anterior spine, hind tibial spurs separated such that one spur is inserted near apex of spine and the other in the corium (Fig. 24j) (1). [Apex of hind tibia of male simple, hind tibial spurs normal, in close approximation and both inserted in the corium.] In the Anthophorini this is an autapomorphy of *Anthophoroides* and rarely seen in other Anthophorinae. Such a peculiar modification of the male hind tibia must be an apomorphy.

31. Posterior inner surface of female hind basitarsus with longitudinal cavity (Fig. 18h) (1). [Posterior inner surface of female hind basitarsus convex or angulate.] This character is unique to *Caranthophora*.

32. Hind femur of male dilated, bulbous (Figs. 24i, 24j) (1). [Hind femur of male normal, slender.] Such a peculiar modification of the male hind femur is not necessarily correlated with a toothed hind basitarsus. This unusual modification must be an apomorphy.

33. Pygidial plate of male with carinate margins, dorsally flattened (Fig. 13c) (1). [Pygidial plate of male, if present, without carinate margins.] Carinate margins are unique to *Pyganthophora*. I am uncertain as to whether the presence or absence of a male pygidial plate is apomorphic. Following the reasoning given in character 26, a pygidial plate on a male may be an apomorphy. Males of *Amegilla,* eucerine, melitomine and exomalopsine bees all lack pygidial plates but habropodine bees possess them. Even though the Habropodini are the sister group to the Anthophorini, almost all the rest of the male Anthophorinae lack pygidial plates and thus I believe the presence of one is an apomorphy. On the other hand, the presence of a male pygidial plate could be an apomorphy indicating sister group relationship of the Anthophorini and Habropodini. The loss of the pygidial plate would then be an apomorphy within the Anthophorini.

34. Pygidial plate of male without carinate margins but dorsally rounded (Fig. 15c) (1). [Pygidial

plate of male absent or if present, dorsally flattened.] See comments under character 33. This modification of the male pygidial plate is a weak apomorphy since it apparently has arisen several times in the Anthophorini.

35. Gradular process of T7 of male present (Fig. 2g) (1). [Gradular process of T7 of male absent.] This structure among the Anthophorinae is found only in a few groups of Anthophorini and Eucerini. This unusual modification is therefore considered an apomorphy.

36. Apical margin of T7 of male deflexed anteriorly, deflexed portion wide (Fig. 27f) (1). [Apical margin of T7 of male deflexed anteriorly, deflexed portion narrow.] This apomorphy is unique to *Dasymegilla*.

37. Apical margin of S6 of male emarginate (1). [Apical margin of S6 of male entire.] Some species of *Amegilla* have a slightly emarginate S6. All Habropodini have an apically entire S6. An emarginate sternum is probably an apomorphy.

38. S6 of male with pair of oblique ridges diverging distally on apical half (Fig. 14d) (1). [S6 of male without ridges.] A unique structure found only in *Lophanthophora*.

39. S6 of male with dense pad of hair on basal half of disc, not situated in a depression (Fig. 27f) (1). [S6 of male sparsely pubescent, if with a dense pad, then pad situated in a depression.] This structure is unique to *Dasymegilla*.

40. S5 and 6 of male (sometimes 4) with a dense pad of hair in depression and covering most of disc (Fig. 30a) (1). [All sterna without dense pads of hair in special depressions.] This is an apomorphy of some Old World *Heliophila*.

41. S7 with short apodemes, length of apodeme much less than length of disc (Fig. 32e) (1). [S7 with long apodemes, subequal to length of disc.] Long apodemes are found in most *Anthophora* and *Amegilla*. The apodemes are extremely short only in *Caranthophora* (Fig. 18d). Most *Heliophila* have moderately short apodemes.

42. Apodeme of S7 with strong lateral projection (Fig. 27d) (1). [Apodeme of S7 simple.] This synapomorphy is unique to *Petalosternon* and *Dasymegilla* and not found in the outgroups.

43. S8 with narrow apex (Fig. 26e) (1). [S8 with wide apex.] The apex of S8 of melitomine, eucerine, and centridine bees is wide. Presumably a narrow apex in certain anthophorine groups is an apomorphy.

44. S8 with long spiculum (Fig. 25c) (1). [S8 with normal, short spiculum.] This structure is unique to *Anthomegilla*.

45. Gonostylus absent (2). Gonostylus short, ten times or less longer than wide (1). [Gonostylus long, more than ten times longer than wide.] Exomalopsine to habropodine bees have narrow, elongate gonostyli. The gonostylus has been reduced apomorphically in many anthophorine groups.

46. Gonostylus sclerotized, concolorous with gonocoxite (1). [Gonostylus absent or membranous, lighter in color than gonocoxite.] This apomorphy is unique to *Clisodon*.

47. Penis valve apex small or greatly narrowed, at most 1.5 times as long as wide (Fig. 19a) (1). [Penis valve apex large, not narrowed, greater that 1.5 times as long as wide.] A large penis valve apex is found in melitomines and eucerines. The penis valves have become greatly reduced in many groups of *Anthophora,* this reduction presumably is an apomorphy.

48. Penis valve bridge long and narrow, at least 1.5 times as long as wide (1). [Penis valve bridge short and broad, less than 1.5 times as long as wide.] It appears that an elongation and narrowing of the penis valve bridge basally is an apomorphy since all non-anthophorine Anthophorinae have a broad triangular penis valve bridge with no basal elongation. Within the Anthophorini the bridge has been elongated up to three times as long as wide.

49. Base of penis valve bridge elongate and emarginate (Fig. 2d) (1). [Base of penis valve bridge simple.] In the Anthophorinae, excluding the anthophorine bees, the penis valve bridge is broad, triangular and apically simple. Thus, an apomorphy in the Anthophorini is a basal elongation usually accompanied by an emargination.

50. Penis valve bridge basally prolonged as an acute projection (Fig. 26h) (1). [Penis valve bridge without basal acute projection, instead basally blunt or emarginate.] This apomorphy is unique in *Rhinomegilla*.

51. Penis valve bridge without basal elongation but with deep emargination (Fig. 25f) (1). [Penis valve bridge basally elongated.] This condition is only found in *Anthomegilla*.

52. Apex of gonocoxite complex, with two subapical plate-like carinae, one dorsoventral, the other lateral (Figs. 16j, 16k) (1). [Apex of gonocoxite relatively simple, without subapical plate-like carinae.] This is an autapomorphy of *Mystacanthophora*.

53. Apex of gonocoxite flattened and hooked ventrad (Figs. 14a, 14b) (1). [Apex of gonocoxite variously shaped, not flattened and hooked ventrad.] This apomorphy is unique to *Lophanthophora*.

54. Apex of gonocoxite darkly sclerotized, distinctly demarcated from moderately sclerotized base of gonocoxite (Fig. 24f) (1). [Apex of gonocoxite concolorous with base of gonocoxite.] This apomorphy, found in *Anthophoroides,* does not occur in other anthophorids.

55. Gonobase small, in profile much wider than long (Fig. 28e) (1). [Gonobase large, in profile at

least half as long as wide (Figs. 19b, 30i).] All habropodine and eucerine bees have large gonobases. The gonobase has presumably become apomorphically reduced in various anthophorine groups.

56. Female constructs turret of mud over nest entrance (1). [Female leaves nest entrance unmodified, without turret.] Even though the old literature gives the reader the impression that most *Anthophora* build turrets, they are actually unique to *Melea*.

57. Stinging behavior absent (1). [Stinging behavior present (1).] An obvious apomorphy of *Melea*.

58. Batesian and/or Müllerian mimicry of bumblebees (1). [No apparent mimicry of bumblebees.] Another autapomorphy of *Melea*.

59. Nest constructed in wood (1). [Nest constructed in earth.] Only *Clisodon* nests in wood, with the possible exception of *Anthophora (Anthophoroides) signata*. Since all melitomine, eucerine and habropodine bees nest in the soil, soil nesting presumably is primitive.

60. Gonostylus fused to gonocoxite (1). [Gonostylus articulated with gonocoxite.] Melitomines, eucerines and habropodines all have articulated gonostyli. Presumably the fusion of the gonostylus to the apex of the gonocoxite is an apomorphy found in anthophorine as well as centridine bees (except *Caenonomada*).

61. Bridge of penis valves basally elongated and often emarginate (1). [Bridge of penis valves triangular, basally simple and either square or bluntly pointed.] All Anthophorinae have the plesiomorphic type of bridge of penis valves except the Anthophorini which have the bridge of the penis valves elongated to varying degrees.

62. First recurrent vein of forewing meeting posterior margin of second submarginal cell near its midpoint (1). [First recurrent vein meeting or nearly so with first transverse cubital vein.] Melitomine, eucerine and habropodine bees have the first recurrent vein of the forewing meeting or nearly so with first transverse cubital. Anthophorines have the apomorphic state.

63. Third submarginal cell of nearly equal length on posterior and anterior margins (1). [Anterior margin of third submarginal cell about half length of posterior margin.] All bees in the outgroup have a third submarginal cell which is narrowed anteriorly. All Anthophorini have the apomorphy.

64. S6 of male strongly convex, apically entire, apical margin strongly bent ventrad (1). [S6 of male gently convex, often apically emarginate, apical margin not or only slightly bent ventrad.] The S6 of male centridine and habropodine bees (except pachymelines) is strongly convex, apically bent ventrad and curving only on the lateral margins (few *Anthophora* have the apical margin bent ventrad but the disc is not strongly convex).

65. One gonostylus on gonocoxite of male (1). [Two gonostyli on gonocoxite of male.] All bees in the outgroup have two gonostyli per gonocoxite. One has apparently been lost in the Anthophorini.

66. Gonostyli much flattened and wide, paddle shaped (1). [Gonostyli elongate, usually slightly clubbed or only slightly flattened.] Melitomine, eucerine, centridine and anthophorine bees all have the elongate gonostyli if present. The flattened, paddle shaped, ventral gonostylus is unique to the Habropodini.

67. Stipes with apical concavity, housing the stipital comb, one-fourth length of stipes (1). [Stipes with long apical concavity housing stipital comb, broadly and shallowly emarginate, extending at least one-third length of stipes.] Among the non-parasitic Anthophorinae only the Habropodini and the Anthophorini have a short round notch housing the stipital comb. This is a strong synapomorphy uniting these two tribes.

68. Forewing apically papillate, papillae simple, not tipped with hairs (1). [Forewing apically hairy or if papillate, then papillae tipped with hairs.] Most bees have hairy wings. In Anthophorinae the hairs on the papillae have been lost twice, once in the Centridini *(Centris)* and again in the habropodine-anthophorine lineage.

69. Tibial scopa consisting largely of simple hairs on outer surface (1). [Tibial scopa consisting largely of plumose hairs on outer surface.] Almost all non-parasitic female Anthophorinae have the tibial scopa consisting mostly of plumose hairs, except the Habropodini and Anthophorini in which the scopal hairs are largely simple, sometimes with some plumose hairs along the anterior and posterior margins.

70. Jugal lobe of hind wing one-third or less length of vannal lobe measured from wing base (1). [Jugal lobe of hind wing at least one-half length of vannal lobe.] All Anthophorinae except the Habropodini and Anthophorini have relatively long jugal lobe one-half to three-fourths the length of the associated vannal lobes. (Large species of *Pachymelus* have the jugal lobe nearing one-half the length of the respective vannal lobe.) The shortening of the jugal lobe must be an apomorphy.

TABLE 2. MATRIX OF CHARACTERS LISTED IN TABLE 1.

Variables 1-59 are represented by the columns from left to right and concern *Amegilla* and the subgenera of *Anthophora*. Similarly variables 60-70 concern the tribal characters for Anthophorini and Habropodini. Variables which are not constant (i.e., 0 and 1 within the taxon) are indicated by P; the 0 was used in the cladistic analysis.

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Variables                1111111111222222222233333333334444444444555555555
                         1234567890123456789012345678901234567890123456789012345678
Amegilla                 102010000000001100000000000000000000000001010100000000000
Anthophora               100000000010000100OP1100100000000001000000100100000000000
Lophanthophora           200000000000000001000PP1000000000011001000000P0P100001000000
Pyganthophora            2P000000000000000100OPPP0000000010P01000P00010P100010000000
Petalosternon            1000001000000000100000000000000P000010000100P00P00000000000
Clisodon                 0000001000100000100000001110000000101000000011010000000001
Dasymegilla              0P000010100000001000000000000000000011010011010010000001000O
Caranthophora            0120000000000000100101010100001100001000100010101000001000O
Heliophila               PPPP00PP0P0000001P0000000P1P00000PP0P00PP0P0101PP00000P0000
Melea                    0000000000000000010100001011010000000100000101010100000011110
Anthophoroides           0P000000000000001010000101000101000010000010101010000100000
Rhinomegilla             1000000020000100100000000110000000000000001010101100001000O
Anthomegilla             1000001020001000100000000110000000000000001120101010001000O
Paramegilla              1P000000000000001000000P0000000P0100100000101OP1P0000000000
Mystacanthophora         0100010000000000100000000100000000001000P000P0P100010000000

                         66666666667
                         01234567890
ANTHOPHORINI             11110101111
HABROPODINI              00001011111
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TABLE 3. LIST OF VARIABLES OF THE SUBGENERA OF *AMEGILLA*.

The explanation is as for Table 1.

1. Galea long, attaining in repose middle of midcoxa to surpassing slightly hind coxa (2). Galea attaining in repose only middle of midcoxa (1). [Galea only rarely attaining anterior edge of midcoxa.] Presumably tongues have elongated either in adapting to or coevolving with flowers which now have long nectar spurs or deep tubular corollas. The greatest tongue length has been achieved in *Glossamegilla* in which glossal length often exceeds 2 cm. Long tongues of this kind are not found in habropodine (except *Elaphropoda*) and eucerine bees, and are apomorphic.

2. Maxillary palpus with 4 segments (2). Maxillary palpus with 5 segments (1). [Maxillary palpus with 6 segments.] The 4-segmented maxillary palpus of *Notomegilla* appears to have evolved from a 5-segmented ancestral form since one species of *Notomegilla, A. chlorocyanea,* has 5 segments and *Notomegilla* is closely related to *Asaropoda* which has 5-segmented maxillary palpi. The loss of segments from a 6-segmented maxillary palpus, common to most bees, is an obvious apomorphy.

3. Female with pale paraocular marks (1). [Female without paraocular marks (1).] No habropodine or eucerine females have paraocular marks. Therefore, the presence of these marks presumably is an apomorphy.

4. S4 of male modified, apical margin bent ventrad (Fig. 39a) (1). [S4 of male normal, apical margin flat.] No habropodine, centridine or eucerine bees have a similarly modified S4. In *Amegilla* this character is found only in *Asaropoda*.

5. S5 of male modified, apical margin broadly and deeply emarginate (Figs. 37e, 39a) (1). [S5 of male normal, apical margin entire.] Most male bees in the outgroup have unmodified, entire apical margins of the S5. The apomorphy is unique to *Zonamegilla* and *Asaropoda*.

6. S5 of male with a dense patch of hair laterally (Fig. 37e) (1). [S5 of male with pubescence of disc distributed more or less evenly, no dense patch of hair near lateral margin.] The autapomorphy is found in *Zonamegilla*.

7. S6 of male with medioapical margin strongly convex (Figs. 37e, 39a) (1). [S6 of male with medioapical margin flat like lateral apical margin.] The apomorphy is unique to *Zonamegilla* and *Asaropoda*.

8. A large lateral tooth near end of apodeme of male S7 (Fig. 38d) (1). [Apodeme of S7 of male simple, lateral margins more or less parallel.] This tooth is found only in *Notomegilla.*

9. Lateral margin of S7 of male with a tooth on basal half (Fig. 36h) (1). [Lateral margin of S7 of male without a tooth on basal half.] The Habropodini lack this structure but some groups of *Amegilla* and *Anthophora* have it.

10. S7 of male with width of disc on basal two-thirds equal to about half of width of disc on apical third; basal two-thirds almost parallel-sided (Fig. 35h) (1). [S7 of male with width of disc varying on basal two-thirds such that basal two-thirds is not parallel-sided.] Eucerini, Habropodini and *Anthophora* do not have S7 with a long parallel-sided disc which is slightly expanded on apical third. Such a structure is presumably an apomorphy.

11. S8 of male with two well developed basal processes (Fig. 38c) (1). [S8 of male simple, without any basal processes.] This is an autapomorphy of *Notomegilla.*

12. Median apical lobes and lateral lobes protruding from apex of S8, with margin between them strongly emarginate (Fig. 37i) (1). [Median apical lobes weakly developed or lateral lobes absent; margin between them only weakly emarginate to entire.] This structure is only found in *Micramegilla.*

13. S8 of male apically narrowed, lateral margins converging apically (Fig. 37c) (1). [S8 of male apically broad, lateral margins more or less parallel (Fig. 36c).] Almost all males in the outgroup have broad eighth sterna. The apical tapering of this sternum is presumably an apomorphy.

14. Gonobase in lateral view much longer than wide (Fig. 36g) (1). [Gonobase in lateral view about as long as wide to wider than long.] This apomorphy is only found in *Ackmonopsis.*

15. Gonostylus greatly reduced to only a membranous blister or absent on gonocoxite (1). [Gonostylus present, from 3 to 10 times as long as wide.] The absence of a gonostylus is an apomorphy since all bees in the outgroup have gonostyli.

16. Penis valve with strong laterally protruding lobe on apical half (Fig. 36f) (1). [Penis valve with small lobe or no lobe laterally on apical half. This character is unique to *Megamegilla.*]

17. Pubescence metallic (1). [Pubescence not metallic.] None of the non-parasitic bees in the outgroup have metallic hair.

TABLE 4. MATRIX OF CHARACTERS OF THE SUBGENERA OF *AMEGILLA* LISTED IN TABLE 3.

Variables 1-17 are represented by the columns from left to right. Explanation as for Table 2 except P = 1 & 2.

	11111111
	12345678901234567
Anthophora	00000000000000000
Amegilla s. str.	00000000110010100
Zebramegilla	00100000010010100
Micramegilla	00100000100100100
Ackmonopsis	00000000100001100
Megamegilla	11000000000000010
Aframegilla	20000000100000001
Dizonamegilla	10100000000010100
Notomegilla	0P100001101010101
Zonamegilla	20101110100010101
Asaropoda	01011010100010000

CLADISTIC RELATIONSHIPS

The relationships of the Anthophorini-Habropodini to other Anthophorinae are not clear. Michener (1974) placed the Anthophorini (which included Habropodini) between Centridini and Eucerini, positioning the centridines (and the ericrocine-rhathymines) at the "terminus" of the Anthophorinae. This placement seems unjustified now that *Caenonomada* has been reassigned from the Exomalopsini to the Centridini (Snelling and Brooks, 1985). The many plesiomorphies of *Caenonomada* indicate a more ancestral position for the Centridini, possibly near the exomalopsines. If this is correct then the venational apomorphies hitherto used to associate the Anthophorini-Habropodini with the Centridini (i.e., shortening of the second abscissa of M + Cu, loss of hairs on the alar papillae and shortening of the marginal cell) are convergent between the more derived members of Centridini (i.e., *Centris* and *Ptilotopus*) and the Anthophorini-Habropodini. These wing attributes may be associated with large size or rapid flight. Probably the closest relative of the Anthophorini-Habropodini lineage is the Eucerini, the two groups at least sharing a small stigma. The former has diversified and probably arose in the Old World, the latter diversified and most likely originated in the New World.

In the following paragraphs, character numbers in parentheses are from Table 1 except as otherwise indicated.

Because of a strong apomorphy of *Amegilla* (i.e., loss of the arolia), one might suspect that it arose from *Anthophora,* which would thus be paraphyletic. Apparently, however, *Anthophora* is not paraphyletic, but is the sister group of *Amegilla.* The emarginate S6 of the male (37) is a weak apomorphy for *Anthophora* since a few species of *Amegilla* also have an emarginate S6. What lends support to the monophyly (*sensu* Hennig) of *Antho-*

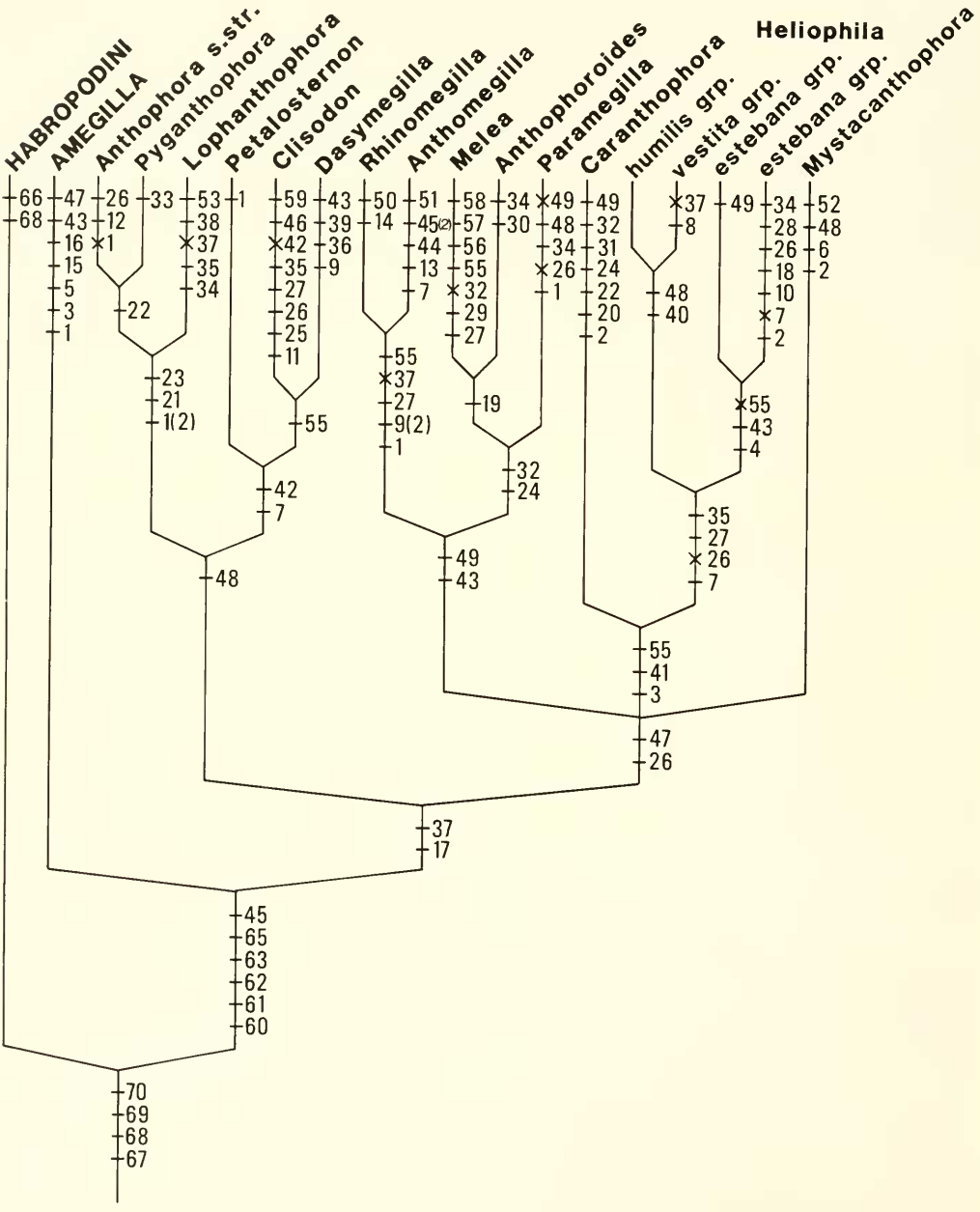

FIG. 40. Cladogram for the genera of Anthophorini and subgenera of *Anthophora.* The numbers represent apomorphies listed in Table 1. Numbers in parentheses represent further derived characters of a variable. An X indicates a reversion.

phora is the bilobed basistipital process (17), which is unique in the Anthophorinae. Even ignoring these characters, I can find no subgeneric group of *Anthophora* from which *Amegilla* might have evolved.

There are four main lineages of *Anthophora* shown in the cladogram (Fig. 40). The first is a group consisting of *Anthophora* s. str., *Pyganthophora* and *Lophanthophora* characterized by long first flagellomeres (1) and males which often have "brushes" of hair on their midlegs (21-23). The second group, consisting of *Petalosternon, Clisodon* and *Dasymegilla,* has males with a trilobed labrum (7) and S7 with a strong lateral tooth on the apodeme (42). The third and most "derived" group contains *Rhinomegilla, Anthomegilla, Melea, Anthophoroides,* and *Paramegilla.* Their male synapomorphies include an apically narrowed S8 (43) and an elongate, basally emarginate bridge of penis valves (49). The fourth group is *Caranthophora,* and *Heliophila.* The females of this group have white to yellow facial markings (3), males have short apodemes on S7 (41) and most have a small gonobase (55).

Figure 41 is an alternate cladogram which gives separate origins for the *Rhinomegilla-Anthomegilla* and *Paramegilla* groups, mainly because the former has males with simple hind legs (24). In addition the *Melea-Anthophoroides* group is shown as the sister group to *Heliophila* because they share a small gonobase which would have to be reversed in the Estebana species group of *Heliophila* (55). I prefer the cladogram in Figure 40 since it appears that *Rhinomegilla* and *Anthomegilla* have their closest relatives among *Melea, Anthophoroides* and *Paramegilla* as suggested by their similar terminalia. The unmodified hind legs (24, 32) of the *Rhinomegilla-Anthomegilla* group probably indicate that it is more ancestral than the *Melea-Anthophoroides-Paramegilla* group. Even though both cladograms are about the same length, the alternate one has five more reversals than the preferred one.

There are two main groups of *Amegilla* (Fig. 42). Six subgenera have S8 in males narrow apically (13, Table 3) and triangular. In the other five this sternum is broad apically and quadrate. The small number of characters used in the analysis of *Amegilla* reflects the homogeneity of this group, and results in a cladistic pattern that might change if additional characters are discovered.

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Unfortunately we have only two fossil records for *"Anthophora."* Cockerell described *A. melfordi* (1908) from Florissant, Colorado. There is no reason to differ with Cockerell's placement of this Oligocene fossil but not all of the diagnostic wing veins are clear (for further discussion see Zeuner and Manning, 1976). The placement is therefore speculative. The single specimen of *"Antho-*

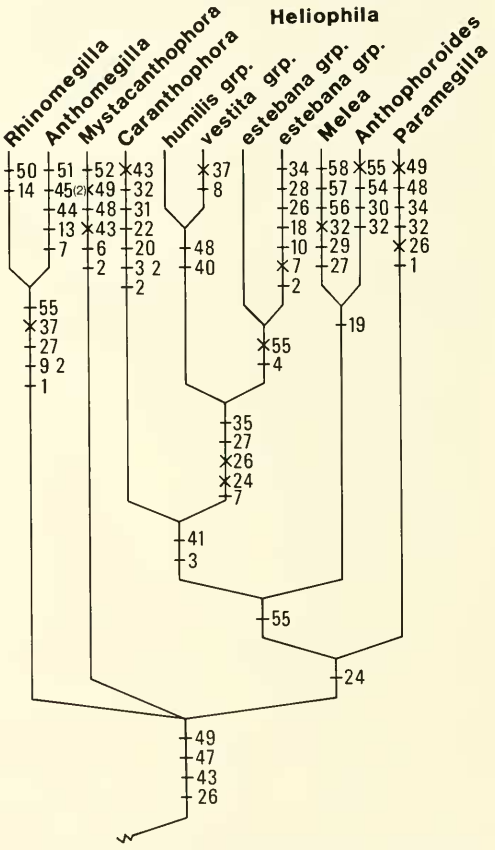

FIG. 41. Alternate cladogram shown for certain subgenera of *Anthophora,* using the same characters as for Fig. 40 but making different assumptions in the main right branch of the cladogram about which characters are convergent. Explanation as for Fig. 40.

phora effosa'' (Heyden, 1862) from Rott, West Germany (Oligocene) also cannot be placed with any certainty in *Anthophora* (Zeuner and Manning, 1976). Thus, this biogeographical discussion has to be based on present distribution and presumed phylogeny.

The greatest diversity of anthophorine species and subgenera occurs in the Mediterranean region which is the tribe's possible place of origin. Of the 14 subgenera of *Anthophora,* eight occur in the New World, of which seven are also Palearctic and only one limited to North America. It is therefore probable that the genus originated in the Old World. The genus *Anthophora* is widespread but conspicuously absent from the Indomalaysian-Australian area. Its absence there is probably due to its being ill-adapted to moist tropical climates through which it would have had to pass, given the present continental arrangement, to reach the temperate parts of Australia. Where it has penetrated the tropics, as in Africa and South America, *Anthophora* is found in montane or xeric habitats. *Anthophora* is apparently a good insular colonizer; it is found in the Cape Verde Islands, Canary Islands, numerous Mediterranean islands as well as the Greater and Lesser Antilles.

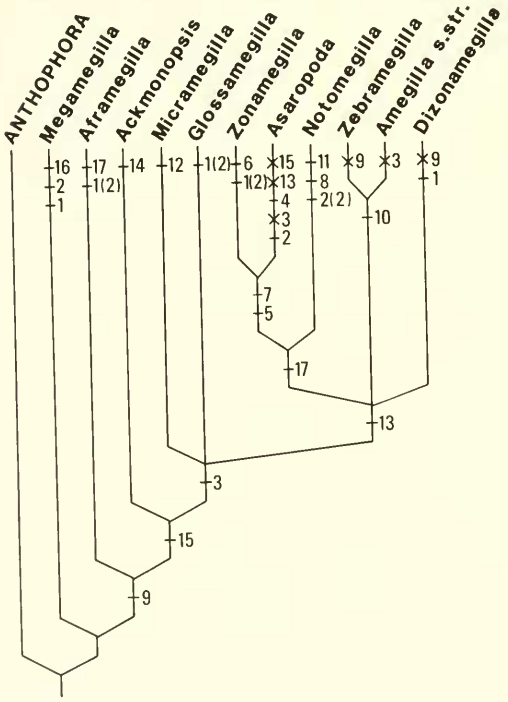

FIG. 42. Cladogram for the subgenera of *Amegilla.* Explanation as for Fig. 40. The apomorphies of the genera *Amegilla* and its sister group, *Anthophora,* are given in Fig. 40.

I recognize five lineages of *Anthophora.* The *Anthophora* group (*Anthophora* s. str., *Pyganthophora* and *Lophanthophora*), the *Clisodon* group (*Clisodon, Dasymegilla* and *Petalosternon*), the *Melea* group (*Melea, Anthophoroides, Paramegilla, Anthomegilla* and *Rhinomegilla*), the *Heliophila* group (*Heliophila* and *Caranthophora*) and the *Mystacanthophora* group *(Mystacanthophora).*

The *Anthophora* group has a disjunct temperate, but in terms of species diversity, a primarily Mediterranean distribution. *Anthophora* s. str. is restricted to the Old World. From its possible Mediterranean origin (seven species), where it is widespread and the species have the most plesiomorphies, it may have dispersed to East Asia (three species). *Pyganthophora* has a more disjunct distribution and is much more speciose than its sister group *Anthophora* s. str. in the Mediterranean region. *Pyganthophora* probably had its origin in the Mediterranean area where it includes at least 39 species many of which are the most ''primitive'' in the group. This subgenus probably was more widespread in the past than it is now because five species are isolated in South Africa and three in northeast China (Beijing area). Possibly there were two introductions of *Pyganthophora* to the New World; the Bering Strait is the most likely route since *Pyganthophora* in the New World is more or less restricted to the western United States. The North Atlantic route, when North America and Europe were much closer, seems less likely. It seems equally unlikely that vicariance explains the distribution of *Pyganthophora.* Of the six species in the New World, three belong to the endemic Crotchii species group and three to the mainly Old World Retusa species group. The New World members of the Retusa species group are typical members, that is, there is nothing in their morphology that sets them apart from the Old World ones. The Crotchii species group, however, is morphologically distinctive. The two species groups are sympatric over only about half of their

ranges in North America. *Lophanthophora* may well have had the same evolutionary past since it has a similar distribution to that of *Pyganthophora,* but lacks any South African members and has a widespread range in both western and eastern United States. Again like *Pyganthophora* it does not range into boreal regions and the New World members are not morphologically distinctive, as a group, from Old World members.

The *Clisodon* group is mainly temperate Palearctic. The most widespread subgenus, *Clisodon,* has only two or three species. One species is Holarctic (Popov, 1951) and inhabits part of northeastern China as well as northern North America. The other one or two species are Palearctic. Vicariance is an unlikely explanation of *Clisodon*'s range, since one species is boreal, occurring well into Alaska, and thence to northeastern China. Most likely this species also occurs in the intervening areas of Siberia. Since the other members of the *Clisodon* group are strictly Palearctic, presumably that is its area of origin. *Petalosternon* possibly originated in the Mediterranean region since 18 of its 21 species occur there.

The *Melea* group includes five subgenera with diverse distributions. *Rhinomegilla* and *Anthomegilla* both occur at high elevations in Asia, mainly in Xizang Province, China (Tibet) and in neighboring areas. *Rhinomegilla* is restricted to Xizang Province and Sikkim. *Anthomegilla* additionally occurs in Mongolia and the forest zone of Siberia. *Paramegilla* is widely distributed in the western Palearctic and Ethiopian regions. In addition, it has two species in the southwestern United States. This distribution may be explained by vicariance, or by former wider distribution. Neither the Old nor New World species are boreal and the two New World species are similar to their Old World counterparts, not unique as a subgroup in any morphological aspect. *Paramegilla* has great species diversity from the Mediterranean region east to the Aral Sea (at least 40 species). In the Ethiopian faunal region a single derived species group (about 10 species) of *Paramegilla* predominates. It seems clear that the area of origin for *Paramegilla* was in the Palearctic. *Anthophoroides* is found only in western North America, south to Honduras. There are 12 species (including six undescribed ones) which are mostly limited to the Mojave and Colorado Deserts. Two species have apparently dispersed to the south, one reaching Jalisco, México and the other Honduras. Since *Anthophoroides* is strictly New World and is the sister group of *Melea,* both may well have originated in the North America. Indeed, of the two species groups of *Melea,* the one with the most ancestral characters is the Bomboides species group, which has three nearctic and one palearctic species.

Of the *Heliophila* group, the member with the most ancestral characters is *Caranthophora.* It is Palearctic with two disjunct areas, one Mediterranean and the other Asian. The Vestita species group of *Heliophila* is subsaharan and has its center of species diversity and probable origin in southern Africa where the most primitive members of *Heliophila* are found. Therefore *Heliophila* probably had its origin in Africa. The Estebana species group is largely restricted to the southwestern United States, but ranges to Honduras. (A single specimen in the Berlin Museum is labelled Guayaquil, Ecuador, perhaps in error.) Southern California and Arizona is the center of species diversity of the Estebana species group (26 species plus one undescribed). Since one if not all of the species ranging into the neotropics also occur in the southwestern United States, they probably dispersed southward from a possible temperate origin.

Mystacanthophora occurs in several disjunct areas. Its largest, more or less continuous range is in North America where one species of the Urbana species group and three species of the Montana species group live. A monophyletic subgroup of the Montana species group is Antillean. The five Antillean species are more closely related to two American species than to the other neotropical members (seven plus one or two undescribed species). This suggests that *Mystacanthophora* invaded the Antilles from Florida. The possible invasion route via the Yucatán peninsula is also less likely because the single Mexican species is more closely related to

the South American species than to the North American and Antillean ones. Almost certainly the Antilles did not receive migrants directly from South America. Since *Anthophora* has proven to be able to cross substantial water barriers, dispersion rather than vicariance seems to explain the New World distributions. Antillean butterflies share a similar history (Brown, 1978).

There is a large gap in the range of *Mystacanthophora* in Central America. South American species mostly are found at high altitudes in the Andean zone and the northern half of Argentina to southeastern Brasil. Across another large gap, two species occur in the Old World, one in Iran and the other from Central Europe to Siberia. Since the most "primitive" species of *Mystacanthophora* is from the United States and the vast majority of species are in the New World, it seems reasonable to suppose that the group had a New World origin.

Unlike *Anthophora, Amegilla* has flourished in the Old World tropics, if one takes species diversity and abundance as a measure of success. The tropics are not barriers to its dispersal. *Amegilla* is also common in xeric areas such as the Mediterranean basin. Apparently it has little tolerance of low temperatures since it is not boreal or montane. Probably this intolerance of low temperatures explains its failure to reach the New World, since transoceanic routes are far northern. Obviously it has crossed moderate oceanic barriers to reach Australia from Asia, but it shows no evidence of having crossed major oceanic barriers.

Amegilla is a much more homogeneous genus than *Anthophora* and few good subgeneric synapomorphies are known. Perhaps its radiation is more recent than that of *Anthophora.* Putting aside the possibility of convergence, it seems that there have been two main lineages of *Amegilla,* (1) those with an apically wide, quadrate, male S8 (Fig. 36c) and (2) those with an apically narrow, triangular one (Fig. 35c). The first four basal subgenera of the *Amegilla* cladogram (Fig. 42) have mainly, if not totally, Ethiopian distributions. This may mean that *Amegilla* had an Ethiopian origin or that its relictual elements survive only in Africa and that representatives of these subgenera have gone extinct elsewhere. *Megamegilla,* the subgenus with the most plesiomorphies, is restricted to Africa, as are *Aframegilla* and *Ackmonopsis. Micramegilla* probably also originated there, since its closest relatives (i.e., *Megamegilla, Aframegilla* and *Ackmonopsis*) are Ethiopian, yet it dispersed into the Palearctic region. *Glossamegilla,* which is related to the last four subgenera as shown by the apically wide male S8, is mainly Oriental but also southeastern Palearctic.

The second group of subgenera, with an apically narrow male S8, is centered more in Australia and southeast Asia than the first group, except *Zebramegilla* and *Amegilla* s. str. which are more western. *Dizonamegilla* consists of three species, one in Somalia, one in India and one in Timor. *Zebramegilla,* the sister group to *Amegilla* s. str., is one of the most widespread subgenera. It occurs over most of Africa, the Mediterranean region, thence to South India and Sri Lanka. *Amegilla* s. str. is more restricted, occurring in eastern and northern Africa, the Mediterranean region and northern India. It is not unreasonable to suppose that both originated in the Ethiopian region since over 90% of their species occur there.

The three remaining subgenera occur wholly or partly in the Australian region. Of these, *Notomegilla* occurs only in Australia, penetrating the interior of the continent, unlike *Asaropoda* whose range is apparently everywhere in Australia except centrally and includes New Guinea and the Bismarck Archipelago. The New Guinean species of *Asaropoda* are similar to those of Australia and probably originated in that continent. *Zonamegilla,* the sister group to *Asaropoda,* is found throughout the Australian and Oriental regions and has slightly entered the Palearctic region. Most of the species of *Zonamegilla* occur in the Indomalaysian area. Since *Asaropoda* is confined to the Australian region it is possible that this was the area of origin for *Zonamegilla* also. On the other hand since Anthophorini are probably relatively recent arrivals in Australia, it is more likely that *Zonamegilla* or its immediate ancestor spread from Asia and gave rise to *Asaropoda* in Australia. Thus only one disper-

sal from Asia to Australia could account for the present Australian fauna.

Evidently major barriers to *Anthophora* dispersal have been oceans and lowland tropics. The only large southern hemisphere *Anthophora* fauna is in southern Africa which is accessible from the North via the east African highlands. Otherwise only one subgenus, *Mystacanthophora,* has crossed tropical regions; it is found in both North and South America and tropical species exist now in the Antilles. To account for the subgeneric dispersal in the northern hemisphere, *Anthophora* must have moved between eastern and western hemispheres at least six times. Most such dispersal was presumably in the North, probably across the Bering Strait area, for it involved subgenera that include species that range into cool to cold climates. The *Heliophila* case (Humilis and Estebana species groups) however, involves groups now restricted to warm and commonly arid regions. Vicariance across the Atlantic or more accurately dispersal across the Atlantic when it was much narrower than at present may well explain the present distribution of this subgenus. The presence of endemic *Anthophora* species on oceanic Atlantic islands shows the potential for dispersal across moderate ocean barriers.

The fact that the biogeography of Anthophorini can be largely, or wholly explained as dispersal, with little evidence of vicariance through continental movement, suggests that this is a group most of whose evolution occurred after the continents had more or less attained their present positions.

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APPENDIX 1. NEW SPECIES OF ANTHOPHORINI

Although many new species of Anthophorini exist, I describe only a few here. They are species of special interest because of morphology or distribution, and are therefore referred to in the subgeneric accounts. Type depositories of new species are indicated in brackets (see Methods).

Anthophora (Mystacanthophora) boharti new species

Diagnosis. Hair Chamois, clypeus protuberant only half width of eye in profile, female face not modified as in most other *Mystacanthophora;* male with metasoma modified, S6 broadly emarginate, S5 apically entire but basal half with thick pile of white hair (Fig. 44f); S7, S8, and genital capsule as in Figures 43a-d.

Description. Male: Length 14.4 mm; forewing

length 9.1 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes .7 frontal length of eye; malar space short; head wider than long; clypeus protuberant, half eye width; labrum apically simple; flagellomere 1 equal to combined length of next two flagellomeres, two-thirds as long as scape (excluding basal bulb) and twice as long as flagellomere 2; flagellomere 2 three-

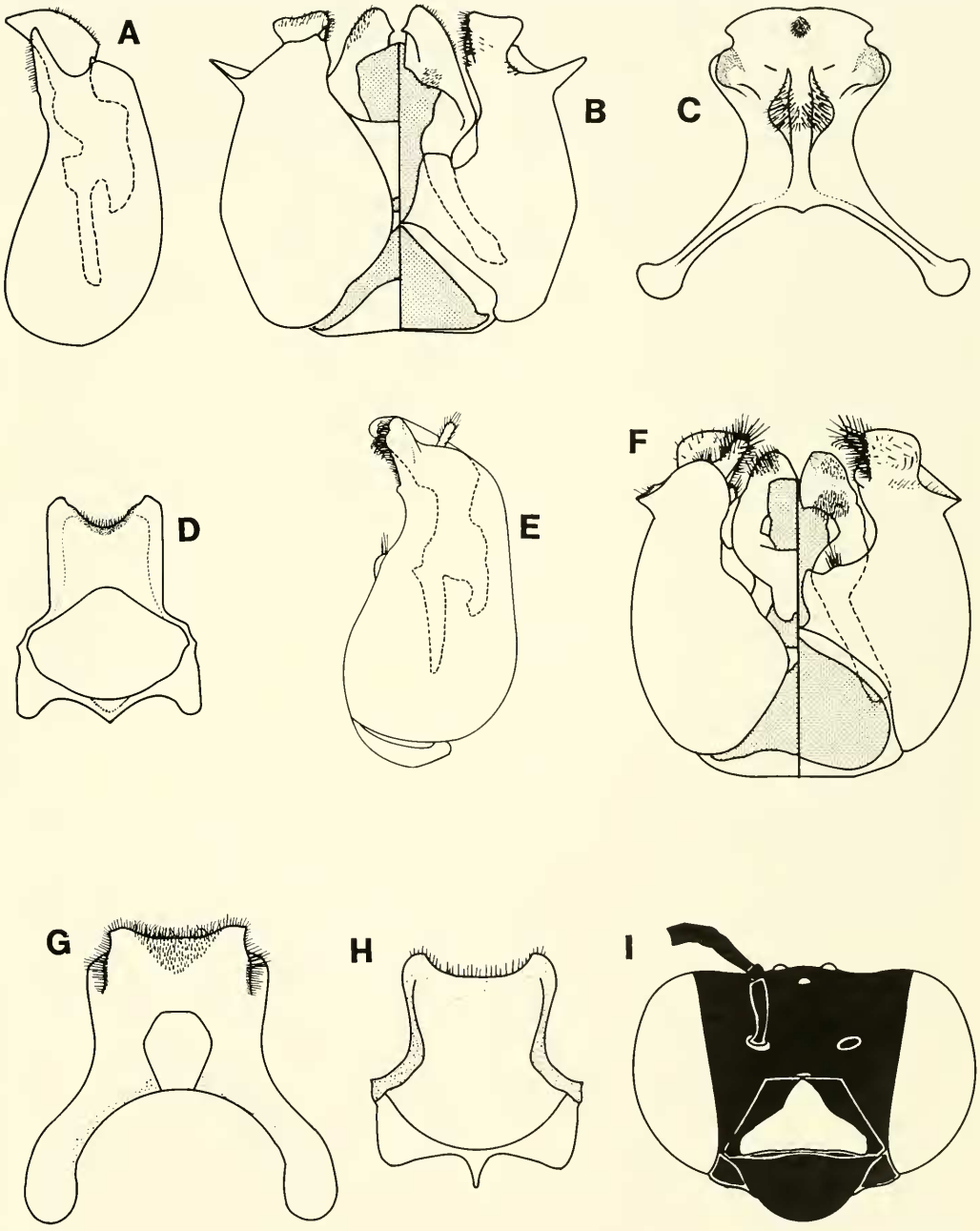


FIG. 43. New species of *Anthophora (Mystacanthophora).* A-D, *A. (M.) boharti* male; E-H, male, I, female, *A. (M.) bahamensis.* A, B, Genital capsule, side and dorsoventral views. C, D, S7 and S8, ventral views. E, F, Genital capsule, side and dorsoventral views. G, H, S7 and S8, ventral views. I, Head of female (hair omitted).

fourths length of 3, 3-10 about equal in length; last flagellomere subequal in length to 1; distance between posterior ocelli about twice ocellocular distance; distance from median ocellus to posterior ocellus slightly shorter than ocellocular distance. S5 and S6 broadly emarginate, other sterna apically entire (Fig. 44f); S7 and S8 as in Figures 43c, d, S7 apically round, not broadly emarginate, lateral margin with two weakly developed lobes, apical margin with only submedian patch of dark setae and disc with large patch of dark setae inserted on raised, laterally carinate ridge; S6 without medioapical protuberance; S5 with a dense pad of white hair covering basal half of disc from gradulus distally (Fig. 44f); genital capsule as in Figures 43a, b. Second submarginal cell receiving first recurrent vein slightly distal to midpoint; cu-v of hind wing about .8 length of second abscissa of M + Cu; vein M 2.7 times as long as second abscissa of M + Cu; jugal lobe about one-third length of vannal lobe. Pygidial plate absent, apparent medioapical margin of T7 with two blunt lobes. *Coloration.* Brownish black, mouthparts (including basal half of mandible), veins, tegula, legs, and S1-S4 Burnt Sienna; labrum, clypeus, paraocular area up to insertion of scape, supraclypeal area, and scape anteriorly white; wings clear. *Pubescence.* Chamois, except for two black patches of hair on inner margin of hind leg, one on apex of trochanter, other at base of femur; apical margin of S5 with band of dark hair, thicker laterally and with thicker median patch; apical margin of S4 with pair of submedian patches of dark hair (Fig. 44f); pile of head and thorax about length of scape, propodeal area with longer hair about length of midtibia, hair of legs and metasoma short, about length of flagellomere 2 but longer on lateral edges of S3-S4; hair of terga more or less evenly covering visible surfaces but forming indistinct apical bands; S5 basally with thick pad of white hair (Fig. 44f), S2-3 basomedially with a thick patch of white hair. *Punctation.* Clypeus, paraocular and supraclypeal areas shiny, lacunose, ground between punctures smooth; labrum shiny, lacunose, ground between punctures weakly microareolate; upper half of face shiny, puncticulate, ground between punctures smooth; scutum dull but weakly shining at margins and pleura dull, microareolate; T1-T6 shiny, densely punctate with impunctate apical margins, ground between punctures weakly microareolate to smooth; S1-S3 with scattered punctures, S4-S6 with more densely spaced punctures, all sterna shiny with ground between punctures microareolate.

Female: Length 14.3 mm, forewing length 9.3 mm. Agrees with description of male except for sex-limited characters and as follows: *Structure.* Shortest distance between eyes .9 length of eye; flagellomere 1 equal to combined length of next three flagellomeres and .83 length of scape, flagellomeres 2-9 about equal in length, flagellomere 10 slightly longer than preceeding flagellomere. *Coloration.* Black except legs and sterna Burnt Sienna, sometimes with a small medioapical pale spot on clypeus. *Punctation.* Face shiny; clypeus and supraclypeal area rugulose-lacunose; labrum and paraocular area rugose; upper face puncticulate, all ground between punctures on face smooth to weakly microareolate; center of scutum shiny, impunctate, smooth, margins of scutum shiny, microareolate; pleura weakly shining; T1-T6 shiny, puncticulate, apical margins impunctate, ground between punctures smooth.

Type material. Holotype male and allotype female: Iran: Hamadan, 10 August, 1964, collected by George E. Bohart, the holotype on basil *(Ocimum basilicum).* Female paratypes were collected in Iran by Bohart at Cazemabar (one female, 9 August 1964) on *Medicago sativa,* at Drazan on *"Salvia"* (one female, 9 August 1964), and at the base of Damayand Mt. (2 females, 14 August 1964). The type series is deposited as follows: Male holotype and allotype [Washington], two female paratypes [Lawrence] and two female paratypes [Logan].

Comments. This species is one of two members of its subgenus that occur in the Old World. It can be separated from *A. borealis* by the much larger size (*borealis* is 10-11 mm), in the male by the large black area basolaterally on the clypeus and the patches of pale hair apically on S5 and S6. Additionally, *boharti* has essentially all hair pale on the head, thorax and metasoma; in *borealis* the pale hair there is intermixed with much black.

Etymology: This species is named after Dr. George E. Bohart, the collector. I gratefully acknowledge the generous loan of various species of the Estebana group of *Heliophila* and his comments on this group, which greatly facilitated this study.

Anthophora (Mystacanthophora) bahamensis new species

Diagnosis. Female with Marguerite Yellow integumental mark on clypeus (Fig. 43i); metasomal terga with apical Ochraceous Buff integumental bands of hair.

Description. Female: Length 11 mm; forewing length 8 mm. *Structure.* Inner orbits diverging above (Fig. 43i); shortest distance between eyes .8 length of eye; malar space short; head wider than long; clypeus relatively undeveloped, clypeus moderately protuberant, in profile .4 width of eye; flagellomere 1 equal to combined length of next 2.8 flagellomeres, .6 as long as scape (excluding basal bulb) and 1.4 times as long as last flagellomere, flagellomeres 2-9 about equal in length and as long as wide; distance between posterior ocelli about equal to ocellocular distance, distance of median ocellus to posterior ocellus half ocellocular distance; second submarginal cell receiving first recurrent vein slightly distal to midpoint; cu-v of hind wing equal in length to second abscissa of M + Cu; vein M 4.3

times as long as second abscissa of M + Cu; jugal lobe about one-third length of vannal lobe. *Coloration.* Brownish black except mouth-parts (including basal two-thirds of mandible), legs, veins, and metasomal sterna reddish brown; clypeus with pale integumental mark (Fig. 43i); wings clear. *Pubescence.* Ochraceous Buff, except paler on face, pleura and thoracic sterna; a few dark hairs near posterior ocelli, center of scutum, on visible portions of T2-T6, and dense around pygidial plate; pile on head, thorax (except propodeal area where length is slightly longer), T1 and sterna about equal in length to scape and erect, posteriorly inclined; hair on T2-T6 shorter than scape; apical bands of hair on terga absent. *Punctation.* Face dull; clypeal, paraocular and supraclypeal areas lacunose, ground between punctures strongly microareolate; labrum rugose, ground between rugae shiny, smooth; upper face somewhat shining, punctulate, ground between punctures microareolate; scutum and pleura dull, finely microareolate; propodeal area weakly shining, with scattered punctures, ground between punctures microareolate; T1-T4 dull, puncticulate but apical margin impunctate, width of impunctate margin becoming wider from T1-T4, ground between punctures microareolate, T5-T6 punctate, punctures almost confluent to 1 puncture-width apart, ground between punctures microareolate; S1-S6 shiny, with scattered punctures becoming more densely spaced from S1-S6, ground between punctures microareolate.

Male: Length 10.7 mm, forewing length 8 mm. Agrees with description of female except for sex-limited characters and as follows: *Structure and Pubescence.* Flagellomere 1 equal to combined length of next 1.6 flagellomeres together; hind leg simple, basitibial plate absent. Pygidial plate absent, apparent medioapical margin with two blunt lobes; S6 broadly emarginate apically with a medioapical protuberance and lateral depression; S5 apically entire with four patches of black hair, a smaller submedian pair and a larger patch lateral to submedial ones (Fig. 44g); basal two-thirds of disc from gradulus distally with a thick, dense pad of white hair; S4 apically entire; S7, S8 and genital capsule as in Figures 43e-h. *Coloration.* Basal third of mandible, labral, clypeal, paraocular and supraclypeal areas and scape anteriorly white. Punctation. Labrum shiny, lacunose, with ground between punctures smooth.

Type material. Holotype female: Bahama Islands, New Providence, Nassau, 28 June 1904, collected by Allen, Barbour, and Bryant [Cambridge]. Allotype male: Bahama Islands, Nassau, British Museum 1931-343, collected by G. Salt [London].

Etymology. This species is named for the Bahama Islands.

Comments. This species is closely related to *A. tricolor* (Fabricius) from which it is separated in the female by a pale mark on the clypeus and in the male by a pale mark on the mandible and the strong median, longitudinal rounded ridge on S6. The shape of S7, S8 and the genital capsule distinguish *A. bahamensis* from other Antillean *Anthophora.* The species is restricted so far as known to New Providence, Bahama Islands (*A. tricolor* does not occur there).

Anthophora (Anthophoroides) signata new species

Diagnosis. Female with white, integumental, inverted T-shaped mark on clypeus and triangular mark on labrum; male with greatly modified hind leg, tibia dilated with large anteroapical spine and basitarsus greatly flattened with large basoapical spine (Fig. 44e).

Description. Male: Length 10 mm; forewing length 7.4 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes about equal to length of eye; head wider than long; clypeus protuberant, in profile about equal to eye width; flagellomere 1 equal to combined length of next 1.6 flagellomeres together, .52 as long as scape (excluding basal bulb), 1.6 times as long as flagellomere 2, and .92 times as long as last flagellomere, flagellomeres 2-10 about equal in length and about 1.6 times longer than wide; distance between posterior ocelli equal to 1.54 ocellocular distance; distance from median ocellus to posterior ocellus equal to .69 ocellocular distance, labrum with medioapical notch; hind leg modified (Fig. 44e), with femur and tibia dilated, bulbous, apex of tibia with large, anterior spine with outer tibial spur inserted on its apical third, hind basitarsus greatly flattened and with large blunt tooth and apicoanterior small acute tooth; base of inner hind tibial spur partially enclosed, enclosure forming a small, sharp tooth against spur; second submarginal cell receiving first recurrent vein slightly distal to midpoint; marginal cell length .67 distance from apex of cell to wing tip; hind wing with cu-v 1.2 times length of second abscissa of M + Cu; vein M 3.0 times as long as second abscissa of M + Cu; jugal lobe .4 length of vannal lobe; terminalia as in Figures 44a-d. *Coloration.* Black except apices of tarsomeres and claws ferruginous; basal half of mandible, labrum (except translucent basolateral spot), clypeus (except anterior tentorial pit), paraocular and supraclypeal areas, and scape anteriorly white; paraocular area extends from malar space to upper margin of antennal socket; wings clear, veins reddish black. *Pubescence.* Hair white except a few scattered black hairs on vertex; pronotal lobe, scutum, S2-S6, T5-T6 medioapically, T7 all white, and ferruginous hair on inner surfaces of tarsi. Length of hair on face, foretarsus, foretibia, hind femur, thorax, metasomal sterna and T1 slightly longer than length of scape, hair on midleg about length of scape or shorter, hair on forefemur and scopa long, about equal to length of hind tibial spur, hair on visible portions of T2-T5 shorter than length of scape and directed

posteriorly at a 45 degree angle; scutum visible through pile, T2-T6 with sparse scattered hair, without apical hair bands, T1 covered with hair, T7 with all pale hair. *Punctation.* Face weakly shining; clypeus, paraocular and supraclypeal areas lacunose, ground between punctures microareolate; labrum rugulose-lacunose, ground between punctures weakly microareolate; rest of face punctulate, ground between punctures smooth; center of scutum with scattered punctures, becoming more densely punctate to almost confluent toward margins, ground between punctures weakly microareolate; pleura dull, coarsely punctate with punctures separated by 0.5-1.0 puncture widths, ground between punctures microareolate; propodeal area shiny, with scattered punctures, ground between punctures microareolate; T1-T6 weakly shining, foveolate- puncticulate with punctures separated by 0.5-10.0 puncture-widths, except apical margins impunctate, ground between punctures microareolate, T7 more shiny, punctate with punctures sepa-

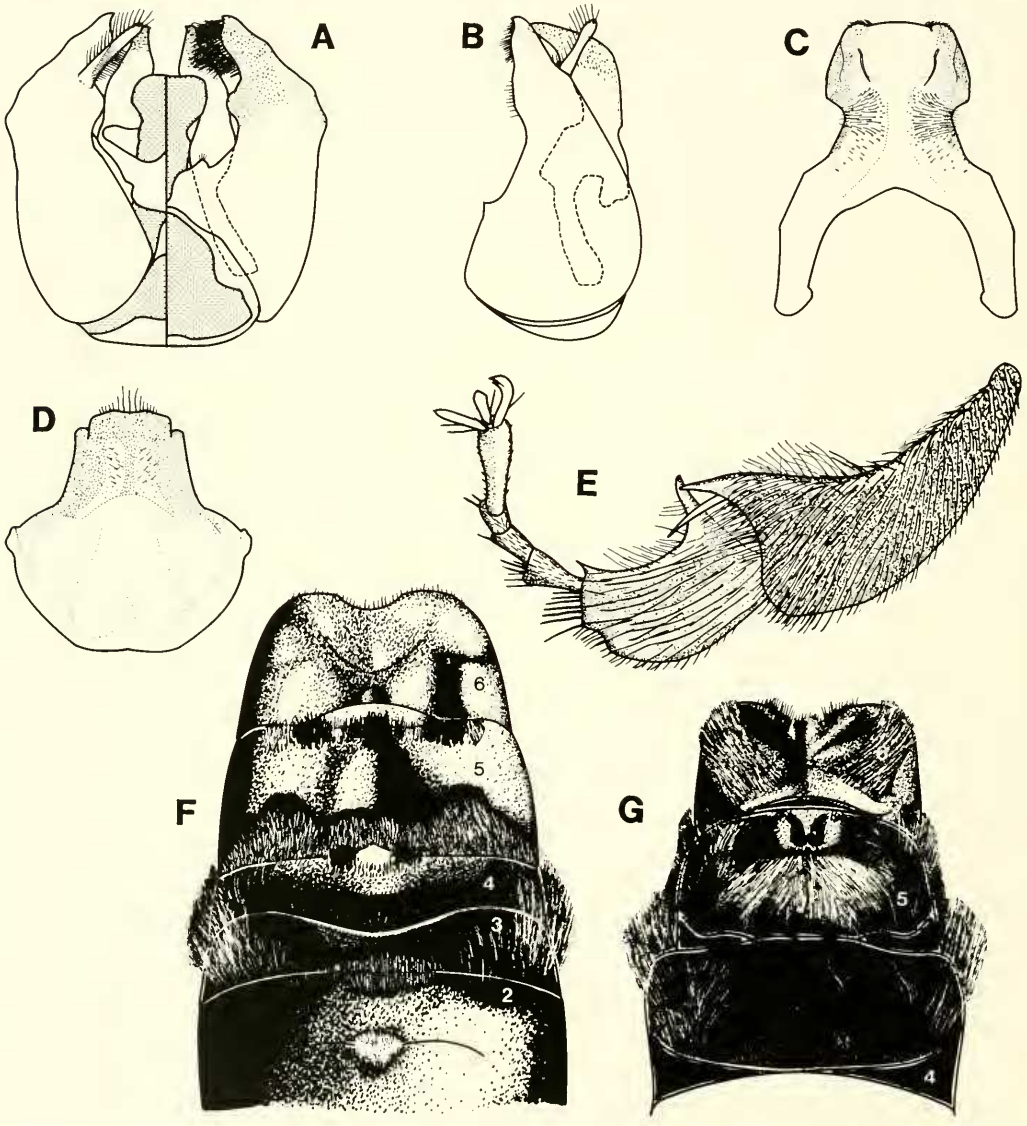


FIG. 44. New species of *Anthophora,* males. A-E, *A. (Anthophoroides) signata;* F, *A. (Mystacanthophora) boharti;* G, *A. (M.) bahamensis.* Numbers refer to the metasomal sterna. A, B, Genital capsule, dorsoventral and side views. C, D, S7 and S8, ventral views. E, Hind leg, outer view. F, S2-S6, ventral view. G, S4-S6, ventral view.

rated by 0.5-1.0 puncture-widths, ground between punctures smooth to weakly areolate; S1-3 with scattered punctures, S4-S6 with punctures becoming denser near apical margins, apical margins impunctate, ground between punctures microareolate.

Female: Length 10-11 mm; forewing length 7-8 mm. Agrees with male description except for sex-limited characters and as follows: *Structure.* Inner orbits diverging above; shortest distance between eyes about equal to length of eye; clypeus protuberant, in profile .75 eye width; flagellomere 1 equal to combined length of next 2.7 flagellomeres, .67 as long as scape (excluding basal bulb) and 1.4 times as long as last flagellomere, flagellomeres 2-9 about equal in length and slightly longer than wide; distance between posterior ocelli equal to 1.25 ocellocular distance, distance from median ocellus to posterior ocellus equal to .56 ocellocular distance. *Coloration.* Black except apices of tarsomeres and claws ferruginous; clypeus and labrum with white integumental marks, that of clypeus shaped like an inverted "T," of labrum triangular. *Pubescence.* T6 surrounded basally with black and laterally white. *Punctation.* Face shiny; clypeus with large punctures separated by 0.3-3.0 puncture widths, ground between punctures weakly microareolate; clypeus with median portion lacunose, laterally rugulose to more finely punctate at margin, ground between punctures near margin microareolate; rest of face foveolate, ground between punctures smooth.

Type material. Male holotype: California, Los Angeles Co., 2.5 mi. (4 km) S. Pearblossom, 3500 feet (1067 m), 14 May 1978, collected on *Salazaria mexicana* by R. W. Brooks; female allotype with same data [Lawrence]. Paratypes: CALIFORNIA: *Inyo Co:* Argus Mts., 1 female, 31 May 1940 (D. Meadows), 2 females, 4 June 1939 on *Penstemon* (R. Bohart); San Lucas Canyon, Inyo Mts., 5800 feet (1768 m), 2 males, 22 June 1978 (T. Griswold); Surprise Canyon, Panamint Mts., 4 males, 24 April 1957 on *Peucephyllum schottii* (J. Powell, P. Hurd), 1 male, 28 April 1953 (G. Marsh), 1 male, 9 May 1958 (L. Stange); Wild Rose Canyon, Panamint Mts., 1 male, 14 May 1969 (P. Opler). *Kern Co:* Last Chance Canyon, El Paso Mts., 2 males, 15 April 1964 (R. Snelling). *Los Angeles Co:* Desert Springs, 2 females, 5 May 1956 (J. Powell); Little Rock, 1 female, 22 April 1950 (C. MacNeil); Mojave Desert, Highway 138, 3600 feet (1097 m), 2 females, 28 April 1947 on *Salvia dorrii* (P. Timberlake); Palmdale, 1 male, 15 April 1956 on *Eriogonum* (R. Erdmann); 15 mi. (25 km) southeast Palmdale, San Gabriel Mts., 2 females, 22 April 1972 from burrows (D. Bixler); 2 mi. S. (3.2 km) Pearblossom, 3500 feet (1067 m), 1 male, 18 April 1977 (R. Snelling), 3 females, 1-2 May 1977 on *Salazaria mexicana* (R. Snelling); 2 females, 17 May 1977 on *Salazaria mexicana* (R. Snelling); 4 mi. (6.4 km) S. Pearblossom, 2 females and 3 males, 13-14 April 1960 on *Salvia* (R. Snelling); 5 mi. (8 km) S. Pearblossom, 1 male, 23 April 1956 on *Tamarix gallica* (E. Linsley); 6 mi. (10 km) SE. Pearblossom, 1 male, 16 March 1972 (R. Snelling). *Riverside Co:* Blythe, 1 male, 2 April 1941 (J. MacSwain, E. Linsley); Joshua Tree National Monument, Quail Springs, 1 male, 12 April 1950 (P. Hurd). *San Bernadino Co.,* 10 mi. (16.6 km) S. Adelanto, 1 female, 3 May 1939 (P. Timberlake); Apple Valley, 1 female, 8 May 1958 on *Gilia latiflora davyi* (P. Hurd), 1 female, 9 May 1958 on *Phacelia distans* (P. Timberlake), 1 female, 9 May 1955 (W. Richards); Hesperia, 1 female, 30 April 1939 on *Tetradymia axillaris* (P. Timberlake); Kramer Hills, 7 mi. (11.6 km) SE. Boron, 1 female, 14 April 1958 (J. Powell), 1 female, 10 May 1955 (W. Richards); Lucerne Valley, 1 female, 7 May 1938 (C. Dammers); Morongo Valley, 1 female, 18 April 1955 (W. Richards); San Bernadino Mts., 3800 feet (1158 m), 1 male, 15 May 1937 (E. Linsley); 7.5 mi. (12 km) S. Twentynine Palms, 1 female, 7 May 1948 on *Salazaria mexicana* (P. Timberlake); 3 mi. (5 km) SW. Victorville, 6 females, 6 May 1939 on *Dalea fremontii saundersii* (P. Timberlake), 2 females, 12 May 1939 on *Haplopappus cooperi* (E. Linsley). NEVADA: *Clark Co:* Charleston Mts., Lee Canyon, 2 females, 25 May 1940 (G. Bohart). Ten paratypes deposited at [Berkeley], 17 [Brooks], 1 [Lawrence], 5 [Logan], 13 [Los Angeles], 2 [Ottawa], 1 [Pullman], 12 [Riverside] and 1 [San Francisco].

Etymology: This species is named *signata* because of the white clypeal mark on the female.

Comments. Anthophora signata and the subgenus *Clisodon* are the only known species of *Anthophora* to nest in wood. At Pearblossom, California, the species nests in old Joshua tree stumps *(Yucca brevifolia)* (R. Snelling, personal comm.) but apparently also burrows in the ground (see data from 15 mi. SE. Palmdale). This species together with *A. bahamensis* (restricted to New Providence, Bahama Islands) are the only known New World *Anthophora* (except *Heliophila*) whose females have white integumental facial marks. *A. signata* can easily be separated from *bahamensis* since it does not have apical pale integumental bands on the metasoma. *A. signata* is most closely related to another undescribed species and *A. phaceliae* from which it can be separated by the unique shapes of S4-S8, the genital capsule and hind leg of the male (Figs. 44a-e). Especially noteworthy is the combination of characters of the male hind leg (Fig. 44e), that is the apical spine on the tibia is bidentate, the tibia is strongly dilated, the basitarsus greatly flattened with the long basal tooth wide, almost bidentate at apex.

Anthophora (Anthophoroides) phaceliae new species

Anthophora abruptella, Marston, 1964, p. 101 (misidentification).

Diagnosis. Head, upper third of thorax in female, all of thorax in male and first metasomal segment covered with ochraceous pubesence; rest of metasoma essentially black with only a few scattered pale hairs in male and all black in female. Shape of hind leg, S7 and S8 and genital capsule shown in Figs. 45a-e.

Description. Male: Length about 10-11 mm; forewing length about 7.7 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes equal to .87 length of eye; head wider than long; clypeus protuberant, in profile .77 eye width; flagellomere 1 equal to the combined length of next 1.5 flagellomeres together, .54 as long as scape (excluding basal bulb) and about as long as last flagellomere, second flagellomere .54 length of flagellomere 1, flagellomeres 3-10 about equal in length, 1.50 times longer than wide, individual segments .83 length of flagellomere 1; distance between posterior ocelli 1.47 ocellocular distance, distance of median ocellus to posterior ocellus equal to .67 ocellocular distance; labrum with medioapical notch; hind leg modified (Fig. 45d); hind trochanter with inner posterior tooth; hind femur and tibia bulbous; hind tibial apex with long anterior spine bearing an apical and subapical acute projection; inner hind tibial spur as in *A. signata;* hind basitarsis longitudinally

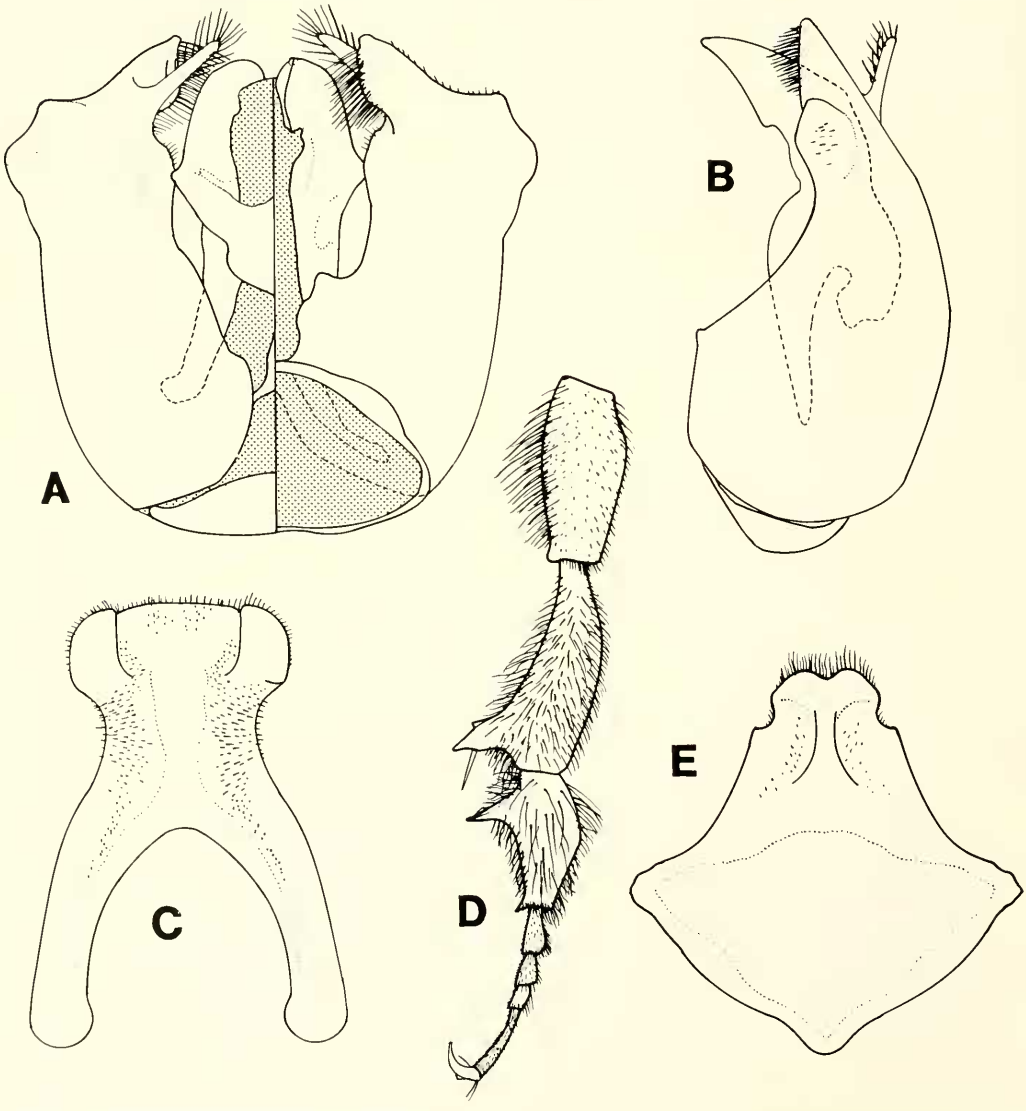


FIG. 45. *Anthophora (Anthophoroides) phaceliae,* male. A, B, Genital capsule, dorsoventral and side views. C, S7, ventral view. D, Outer view of hind leg of male. E, S8, ventral view.

concave on outer surface near posterior margin, anterior basal tooth widened at apex, blunt, and upper anterior surface concave; terminalia as in Figures 45a-c, e. Second submarginal cell receiving first recurrent vein slightly distal to midpoint; marginal cell length 0.80 distance from apex of cell to wing tip; hind wing with cu-v 0.77 times length of second abscissa of M + Cu; vein M 2.72 times as long as second abscissa of M + Cu; jugal lobe .4 length of vannal lobe. *Coloration.* Facial markings as in *A. signata* male. Black except basal half of tarsal claws ferruginous; tegula amber; wings clear, veins reddish brown; legs, S1, S2 and more or less S3 dark ferruginous. *Pubescence.* Hair pale except a few scattered dark hairs on supraclypeal area between antennae and vertex. Scutal pubescence dense, pale with a few scattered dark hairs; rest of thorax, fore and midtibiae all pale; pubescence of head and thorax about equal to length of scape; that of fore and midlegs all black except a pale patch on outer apices of tibiae; hind leg black except pale hair on outer surface of coxa, a pale patch on outer apices of hind femur and tibia; hind basitarsus with a few long pale hairs on outer surface, outer posterior edge of rest of tarsomeres with some pale hair. Metasoma with sparse erect black hair up to length of flagellomere 1; terga with a few pale hairs laterally, T4 and T5 with a sparse weak row of long pale hairs along basal edge of apical impunctate margin; medioapical margin of T7 with some pale hair. *Punctation.* Face as in *A. signata,* weakly shining. Thorax dull, punctation confluent, propodeal area weakly shining. Metasoma as in *A. signata* except terga weakly shining.

Female: Agrees with male description except for sex-limited characters and as follows: Length about 11 mm; forewing length about 8.6 mm. *Structure.* Clypeus protuberant, in profile .67 eye width; flagellomere 1 equal to slightly more than combined length of next three flagellomeres, .79 as long as scape (excluding basal bulb) and 1.59 times as long as last flagellomere, second flagellomere .31 length of flagellomere 1, flagellomeres 3-9 about equal in length, longer than wide, individual segments .37 length of flagellomere 1; distance between posterior ocelli 1.14 ocellocular distance, distance of median ocellus to posterior ocellus equal to .32 ocellocular distance. *Coloration.* Black except basal halves of tarsal claws ferruginous and tegula amber. *Pubescence.* Upper third of pleura and propodeum with dense pale hair, rest of thorax with dense black hair; that of legs all black except pale patch on outer apices of tibiae; appressed scale-like pubescence of basitibial plate golden. T1 with sparse pale pubescence about length of scape; rest of metasoma with sparse erect black hair up to length of flagellomere 1. *Punctation.* Face as in *A. signata* female.

Type material. Male holotype and allotype: California, Solano Co., 3.2 mi (5 km) W. of Mix Canyon, (about 8 km) NW. of Vacaville, 21 April 1976, both collected on *Phacelia egena* (R. W. Brooks), holotype caught at 0900-0915, allotype caught at 1330- 1345 hrs. [Lawrence]. Paratypes: CALIFORNIA: *Contra Costa Co:* Mt. Diablo, 1 female, 21 May 1937 (E. Ross). *Fresno Co:* 6 mi (9.6 km) S. Coalinga, 1 female, 30 March 1970 (J. Powell); 5 mi (8 km) S. Coalinga, 1 male, 1 female, 17 March 1975 (J. Powell); 4 mi (6.3 km) N. Orange Cove, 2 males, 1 female, 6 April 1957, on *Phacelia* (R. Snelling, M. Stage). *Kern Co:* Woody, 1 female, 29 March 1951, (J. MacSwain). *Madera Co:* San Joaquin Experiment Station, 1 female, 20 April 1953 (H. Childs). *Mariposa Co:* Exchequer Dam, 1 male, 1 female, 9 April 1960, on *Phacelia ramosissima* (R. Snelling), 4 mi (6.3 km) W. Echequer Dam, 1 male, 10 April 1960, on *Phacelia* (R. Snelling); Mariposa, 1 female, 14 May 1960 (R. Snelling); Miami Ranger Station, 1 male, 2 June 1937 (J. Kliewer). *Monterey Co:* Arroyo Seco Camp, 5 mi (8 km) W. Greenfield, Elev. 1000 feet (305 m), 1 female, 15 May 1976, on *Eriodictyon californicum* (R. Brooks), 1 female, 1 May 1957 (P. Torchio), 2 females, 2 males, 5 May 1956 (D. Ribble, P. Torchio). *Riverside Co:* Idyllwild, San Jacinto Mts., 1 male, 18 June 1952 (M. Cazier, et al.). *Santa Barbara Co:* Gaviota Pass, 1 female, 23 April 1966, (J. Powell). *San Benito Co:* San Benito, 1 male, 24 March 1971 (E. Cane). *Solano Co:* 3.2 mi (5 km) W. Mix Canyon, Elev. 1700 feet (518 m), 4 females, 17 April 1976, on *Phacelia egena* (R. Brooks), 6 females, 18 April 1976, 4 females, 1 male, 19 April 1976, 6 females, 1 male, 21 April 1976, 1 female, 30 April 1976, 2 females, 3 May 1976; 2 mi (3 km) W. Mix Canyon, Elev. 1000 feet (305 m), 1 female, 16 April 1976, on *Phacelia egena* (R. Brooks), 3 females, 17 April 1976; 1.5 mi (2 km) W. Mix Canyon, Elev. 1000 feet (305 m), 2 females, 10 April 1976, 3 males, 1 female, 14 April 1976, 1 female, 16 April 1976, 1 female, 17 April 1976 (R. Brooks), 1 female, 2 May 1976 on *Collinsia heterophylla* (S. Armbruster). *Stanislaus Co:* Del Puerto Canyon, 1 female, 20 April 1949, (P. Hurd); Knight's Ferry, 1 male, 10 April 1961, on *Phacelia* (R. Snelling), 1 male, 1 female, 15 April 1961 (R. Snelling, T. Duncan). *Tulare Co:* Lemoncove, 1 female, 14 April 1950, (J. MacSwain). *Yolo Co:* Putah Canyon, 2 males, 1 female, 1 May 1940, on *Phacelia* (G. Bohart). *Unknown Co:* Midway, 1 female, 24 May 1936, (M. Cazier). One paratype deposited at [Berkeley], 45 [Brooks], 1 [Cambridge], 1 [Davis], 5 [Lawrence], 5 [Logan], 12 [Los Angeles], 2 [San Francisco], and 3 [Urbana].

Additional specimens: MÉXICO: Baja California, Sierra San Pedro Martir, Rancho Viejo, Elev. 7000 feet (2134 m), 1 female, 13 June 1953 (P. Arnaud).

Comments. The female from Baja California differs from Californian populations in the admixture of several black with pale hairs on scutum, pale pubescence on upper two-thirds of pleura, lower third of pleura and sterna with black hair, outer apices of tibiae with a patch of amber hair, fore and midlegs with pale hair except anterior margin of tarsus with black hair,

hindleg with black hair, except scopal hairs on anterior and posterior margins pale and metasomal terga laterally with sparse pale hair.

Biology. In the Spring of 1976 I studied the floral visitation by *A. phaceliae* at Mix Canyon, Solano Co., California. Females utilized perennial species of *Phacelia* (Hydrophyllaceae) exclusively for pollen and nectar, when available, visiting the flowers from 0730 to 1630 hours. This is the only known oligolectic species of *Anthophora*. The only time *A. phaceliae* was observed going to a plant besides *Phacelia* for pollen or nectar was at the end of its nesting cycle when an extremely worn female was observed on two different occasions taking pollen from *Eriodictyon californicum* (also Hydrophyllaceae) in one locality and *Collinsia heterophylla* at another. Both females were the last females seen at those localities for the season. In both instances at those sites, females were visiting exclusively *Phacelia* a week before.

The bombyliid fly, *Anthrax limatulus vallicola* Marston, has been reared from nests of *A. phaceliae* (Marston, 1964, incorrectly identified as *A. abruptella*).

Anthophora (Caranthophora) spinacoxa new species

Diagnosis. Hind leg of male greatly modified (Fig. 46c); hind coxa with long spine (Fig. 46e); base of hind femur on inner surface with smaller spine (Fig. 46d); S7, S8 and genital capsule shown in Figs. 46g-j.

Description. Male: Length 10.3 mm; forewing length 6.8 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes equal to 0.81 length of eye; head wider than long; clypeal protuberance in profile 0.50 eye width; flagellomere 1 equal to combined length of next two flagellomeres, 0.65 as long as scape (excluding basal bulb) and 1.18 times as long as last flagellomere; second flagellomere 0.42 length of flagellomere 1; flagellomeres 3-10 about equal in length, longer than wide, individual segment 0.66 length of flagellomere 1; distance between posterior ocelli 1.35 ocellocular distance, distance from median ocellus to posterior ocellus equal to 0.65 ocellocular distance. Marginal cell length 0.71 distance from apex of cell to wing tip; hind wing with cu-v 0.85 times length of second abscissa of M+Cu; vein M 2.50 times as long as second abscissa of M+Cu; jugal lobe 0.4 length of vannal lobe. Basitarsus of foreleg with distinct posterior tooth on apex (Fig. 46a), inner surface concave, margins of concavity carinate; mid leg elongated (Fig. 46b); hind leg greatly elongated (Fig. 46c), coxa with large, blunt, spine projecting ventrolaterally (Fig. 46e), femur with small acute, basal tooth on inner surface (Fig. 46d), tibia greatly flattened with wide, flat bilobed, apical tooth on anterior surface with outer tibial spur inserted near base of tooth, basitarsus flattened with large apical tooth on anterior surface. *Coloration.* Dark reddish brown except mandible (except tips), other mouthparts, wing veins and tarsomeres (apices darker) brownish amber; face with white integumental marks as in Fig. 46f. *Pubescence.* Hair pale, white on head, legs and abdomen but ochraceous on thorax except as noted below. Dark hairs scattered among ochraceous ones on scutum and tegula; inner anterior margin of forebasitarsus with short bristly orange hair; midbasitarsus with well developed midbasitarsal brush of black hair (Fig. 46b, black hair on inner apex of basitarsus also) and posterior margin with long loosely associated hairs; middistitarsal brush weakly developed and black; middistitarsus with orange-brown bristles on inner surface; inner surface of hind leg of femur, tibia and anterior half of basitarsus bare and shiny, inner posterior surface of femur, tibia and posterior half of basitarsus with light orange hair, inner surface of tarsus with brown hair. T1 with long erect white hair except apical margin with short appressed white hair; T2-T5 also with apical bands of short appressed white hair and with a few erect dark hairs on basal halves; metasomal sterna with semierect white hair, S4 with a pair of submedian, subapical patches of black hair; S5 with a median V-shaped patch of black hair; S7, S8 and genital capsule as in Figs. 46g-j. *Punctation.* Clypeus shiny, impunctate medially, and laterally with fine punctures; rest of face as usual. Thorax dull, punctures confluent. Metasomal terga weakly shining, punctures fine with areolate sculpturing between punctures.

Type material. Male holotype: Israel, Jericho, 13 April 1909 [Berlin].

Comments and Etymology. Besides the numerous unique characters such as the shape of the hind leg, S7, S8, etc., *A. spinacoxa* is the only species of *Caranthophora* with well developed spines on its hind coxae.

Anthophora (Heliophila) joetta new species

Diagnosis. Facial marks lemon-yellow (Fig. 47a), upper half of thorax with orange hair, lower half with white; mid and hind legs with black hair on outer surfaces; middistitarsus with well developed lateral fringe of black hair (Fig. 47j); T1-T3 with hair all black except narrow apical white band on T3; T4-T6 with white hair and T7 with dark hair; S7, S8 and genital capsule of male as in Figs. 47b, c, h, i.

Description. Male: Length 10.7-13.7 mm; forewing length 8.5-9.1 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes 0.77 frontal length of eye; malar space linear; clypeal protuberance 0.43 eye width; mandible with subapical tooth; labrum with median apical bilobed process (black) and larger median subapical bilobed process (yellow); flagellomere 1 equal to combined length of next 2.5 flagellomeres, 0.58 as long as scape (excluding basal bulb) and 2.5 times as long as flagellomere 2; second flagellomere 0.86 times as long as flagellomere 3; flagellomeres 3-10 about equal in length

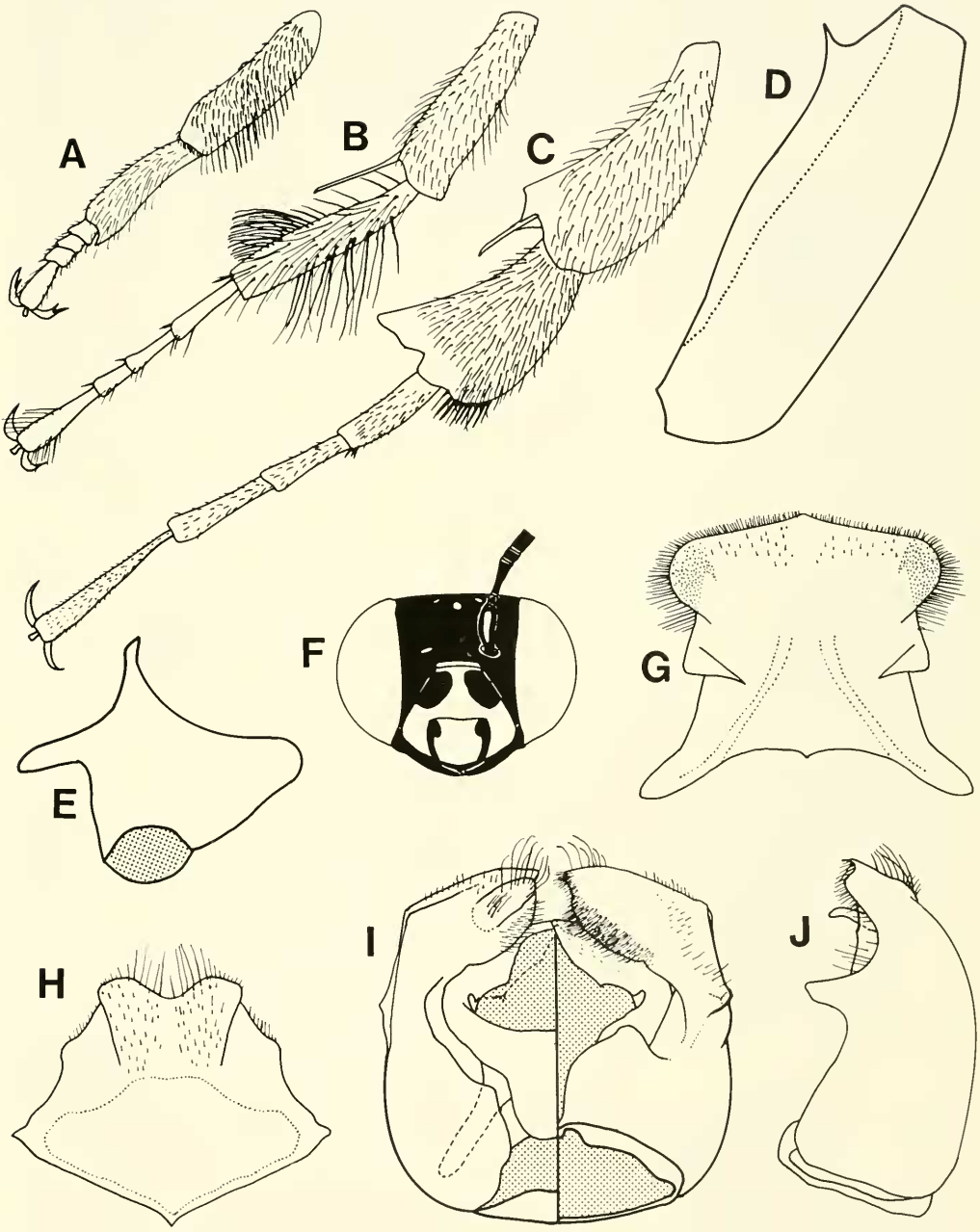


FIG. 46. *Anthophora (Caranthophora) spinacoxa,* male holotype. A-C, Outer views of fore, mid and hind legs. D, Anterior view of hind femur, base of femur at top. E, Hind coxa, side view, base of coxa at top on right side. F, Head, frontal view. G, S7, ventral view. H, S8, ventral view. I, J, Genital capsule, dorsoventral and side views.

vannal lobe; apex of hind tibia on anterior margin with large tooth, outer tibial spur inserted on base of tooth. Pygidial plate apically emarginate, from lateral view with dorsal subapical tooth (Figs. 47d-g); gradular process of T5 developed into a weak tooth, that of T6 a well developed tooth (but see *Comments*) and gradular process of T7 well developed and angulate; S4 apicomedially weakly emarginate; S5 apicomedially deeply emarginate and S6 apicomedially narrowly emarginate; S7, S8 and genital capsule as in Figs. 47c, b, h, i. *Coloration.* Black except facial marks yellow (Fig. 47a) and inner surface of hind tarsus and metasomal sterna reddish-brown. *Pubescence.* Upper half of head and thorax with orange hair, lower half with white hair; foreleg with white hair except anterior surface with blackish-brown hair; midleg with black hair except in inner surface of tarsus (from apical half of basitarsus to claw) white, middistitarsus with well developed lateral

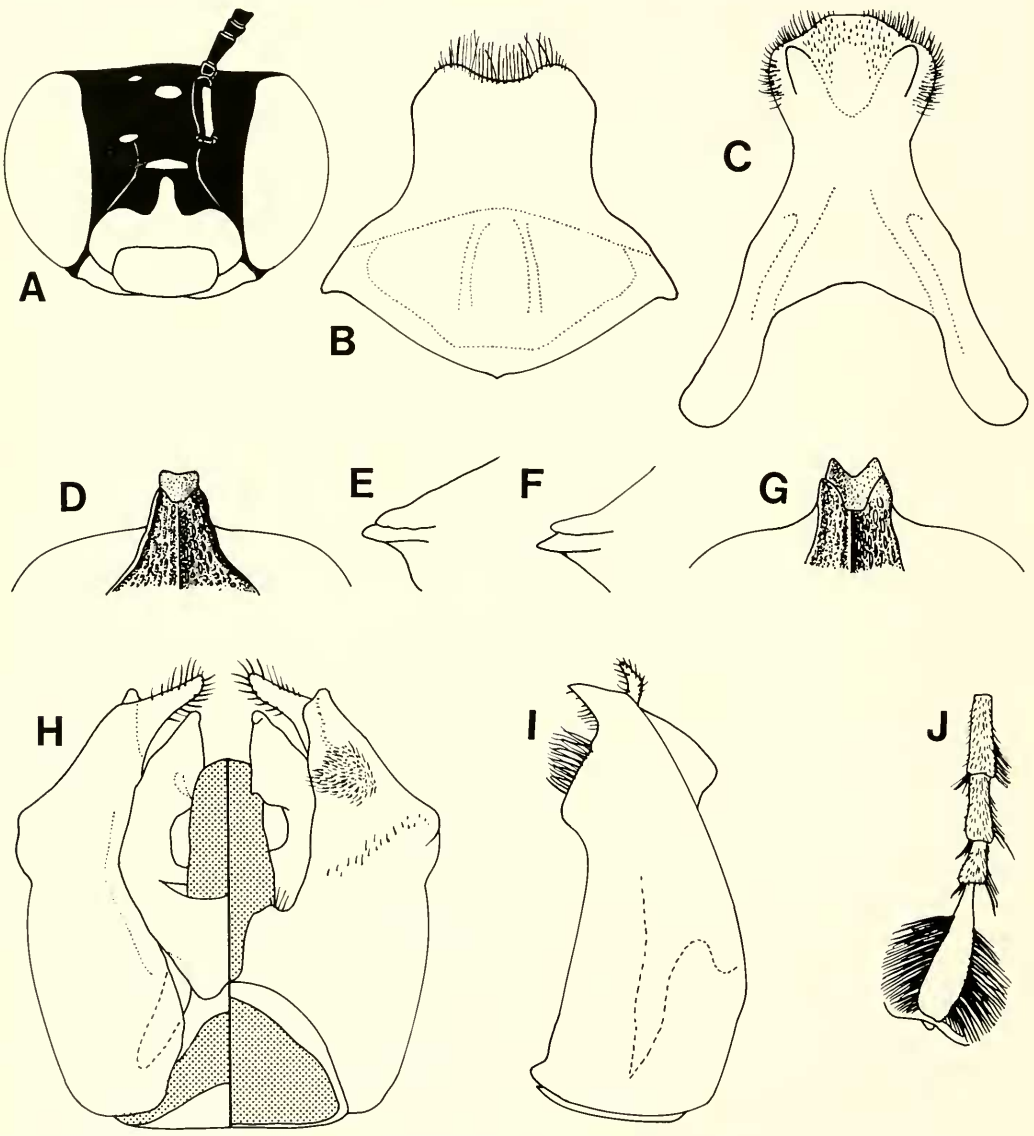


FIG. 47. *Anthophora (Heliophila) joetta,* male paratype. A, Head, frontal view. B, S8, ventral view. C, S7, ventral view. D, E, Apex of T7 of paratype from Zaire, dorsal and side views. F, G, Apex of T7 of holotype from Angola, side and dorsal views. H, I, Genital capsule, dorsoventral and side views. J, Tarsus (excluding basitarsus) of midleg, outer view.

fringe of black hair (Fig. 47j); hind leg with all black except white on inner surface of tarsus (from apex of basitarsus to claw). T1-T3 mostly with black hair but T1 with a few scattered orange hairs and T3 with appressed narrow apical white band; apical half of T4-T6 with white, T7 with orange-brown hair; S1 with pale brownish hair; S2 and S3 with brownish hair, S4 with short brownish hairs apically and laterally but median area (not reaching apical margin) with dense mat of reddish brown hair; S5 with short brownish hair laterally and a narrow band apically but median area (reaching apical margin) with dense mat of yellow orange hair; S6 laterally and broadly apically with short brownish hair but median area (reaching only to apical third) with dense mat of yellow orange hair. *Punctation.* As in *A. micheneri.*

Type material. Holotype male: Angola: 45 mi. [72.4 km] S. Santa Combre Dão, 3 April 1970, Edward S. Ross [San Francisco]. One paratype male: Zaire (B. Congo): 18 mi. [29 km] NW. of Tshinsenda, 8 February 1958, 1330 m altitude, E. S. Ross, R. E. Leech collectors [Lawrence].

Comments. This distinctive species looks superficially much like *Amegilla (Zebramegilla) atribasis* (Cockerell). There is no other species that resembles it in Africa. There are differences between the Angola specimen (holotype) and the Zaire specimen (paratype). The holotype has a distinctive apically emarginate pygidial plate (Fig. 47g) and the gradular process of T6 developed into a tooth whereas the paratype has an almost apically entire pygidial plate (Fig. 47d) and the gradular process of T6 is rounded and not developed into a distinct tooth. The genitalia, however, are identical and although these morphological differences are striking, I believe that they are within the range of variation of this species.

Etymology. This species is named for Joetta Weaver in recognition of her 25 years of painstaking editorial and secretarial contributions for Charles D. Michener and his many students and associates.

Anthophora (Heliophila) micheneri new species

Diagnosis. Body almost completely covered with orange hair similar to that of *Anthophora vestita* Smith; mid and hind legs black except trochanters and coxae with long white hair (male) or mid and hind femur with mostly white hair (female); middistitarsis of male without lateral fringe of black hairs; male and female with bright yellow markings on face (Figs. 48a, b); S7, S8 and genital capsule as in Figs. 48c, f-h.

Description. Male: Length 13 mm; forewing length 7.6 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes 0.79 frontal length of eye; malar space linear; head wider than long; clypeal protuberance 0.42 eye width; mandible with subapical tooth; labrum apically simple and without median subapical process; flagellomere 1 equal to combined lengths of next 1.6 flagellomeres, 0.51 as long as scape (excluding basal bulb) and 1.9 times as long as flagellomere 2, second flagellomere 0.69 times as long as flagellomere 3, flagellomeres 3-10 about equal in length, each 1.22 as long as wide, flagellomere 11 subequal in length to flagellomere 1; distance between posterior ocelli about 1.15 ocellocular distance; distance from median ocellus to posterior ocellus 0.65 ocellocular distance; labrum simple without median apical or median subapical protuberances; cu-v of hind wing about equal in length to second abscissa of M + Cu; vein M 3.53 times as long as second abscissa of M + Cu; jugal lobe about one-third as long as vannal lobe. S4-S6 with dense pads of hair; S7, S8 and genital capsule as in Figs. 48c, f-h. Pygidial plate slightly emarginate apically without sublateral tooth (Figs. 48d, e). *Coloration.* Black except facial marks bright yellow (Fig. 48a). *Pubescence.* Head and thorax on lower half white and upper half yellowish-white; posterior half of scutum with a few scattered dark hairs. Foreleg all white on outer surface, but dark on inner surface; mid and hind legs with hair all black except white on coxae and trochanters and fuscous on posterior surface of midtibia. T1-T6 with appressed orange hair but white to yellow-white laterally; metasomal sterna with white hair, becoming fuscous medially from S3-S6. *Punctation.* Punctures on clypeus and paraocular area fine and separated by 0.5-2.0 puncture widths but fine and nearly contiguous on rest of head. Thorax and metasomal terga dull, weakly shining, punctation contiguous to nearly contiguous.

Female: Length 12 mm, forewing length 8.2 mm. Agrees with description of male except for sex-limited characters and as follows: *Structure.* Shortest distance between eyes 0.91 length of eye; flagellomere 1 equal to combined length of next three flagellomeres and equal to 0.58 length of scape (excluding basal bulb); flagellomeres 2-9 about equal in length and individual segments about as long as wide; last flagellomere 0.77 as long as flagellomere 1; labrum simple without median apical or subapical protuberances. *Coloration.* Facial marks as in Fig. 48b. *Pubescence.* T5 with median patch of dark hair; S1-S3 with sparse apical fringe of white hair; S4 with apical fringe of long white hair and sparse subapical band of dark hair; S6 with dark hair medially, white hair laterally.

Type material. Holotype male and allotype: Kenya: 20 mi. [32.2 km] NE. Magadi, 3500 feet [1066.8 m], 16 June 1967, C. D. Michener [Lawrence].

Comments. This species looks very similar, though smaller in size, to *Anthophora vestita* Smith. The male of *vestita* has a well developed lateral fringe of black hair on the middistitarsus and a deeply emarginate pygidial plate, whereas *micheneri* lacks the fringe of hair on the middistitarsus and has a shallowly emarginate to almost apically

entire pygidial plate. The female of *vestita* has the hind legs with white hairs on the outer surfaces and orange on the inner surfaces, whereas the hind legs of *micheneri* are all black.

Etymology. This species is named for the collector and melittological guide for many students of Apoidea, Charles D. Michener.

Anthophora (Pyganthophora) adamsorum new species

Diagnosis. With mostly red hair; midbasitarsal brush well developed; middistitarsus with weakly developed lateral hair fringe (Fig. 49b); S7, S8 and genital capsule as in Figs. 49c-f.

Description. Male: Length about 13 mm; forewing length about 10 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes 0.81 frontal length of eye; mandible with subapical tooth; head wider than long; clypeal protuberance in profile 0.62 eye width; flagellomere 1 equal to combined length of next 2.7 flagellomeres, 0.87 as long as scape (excluding basal bulb) and 3.3 times as long as flagellomere 2; second flagellomere 0.67 times as long as flagellomere 3; flagellomeres 3-10 about equal in length, each 1.29 times longer than wide; last flagellomere 0.62 times as long as flagellomere 1; distance between posterior ocelli about equal to ocellocular distance; distance from median

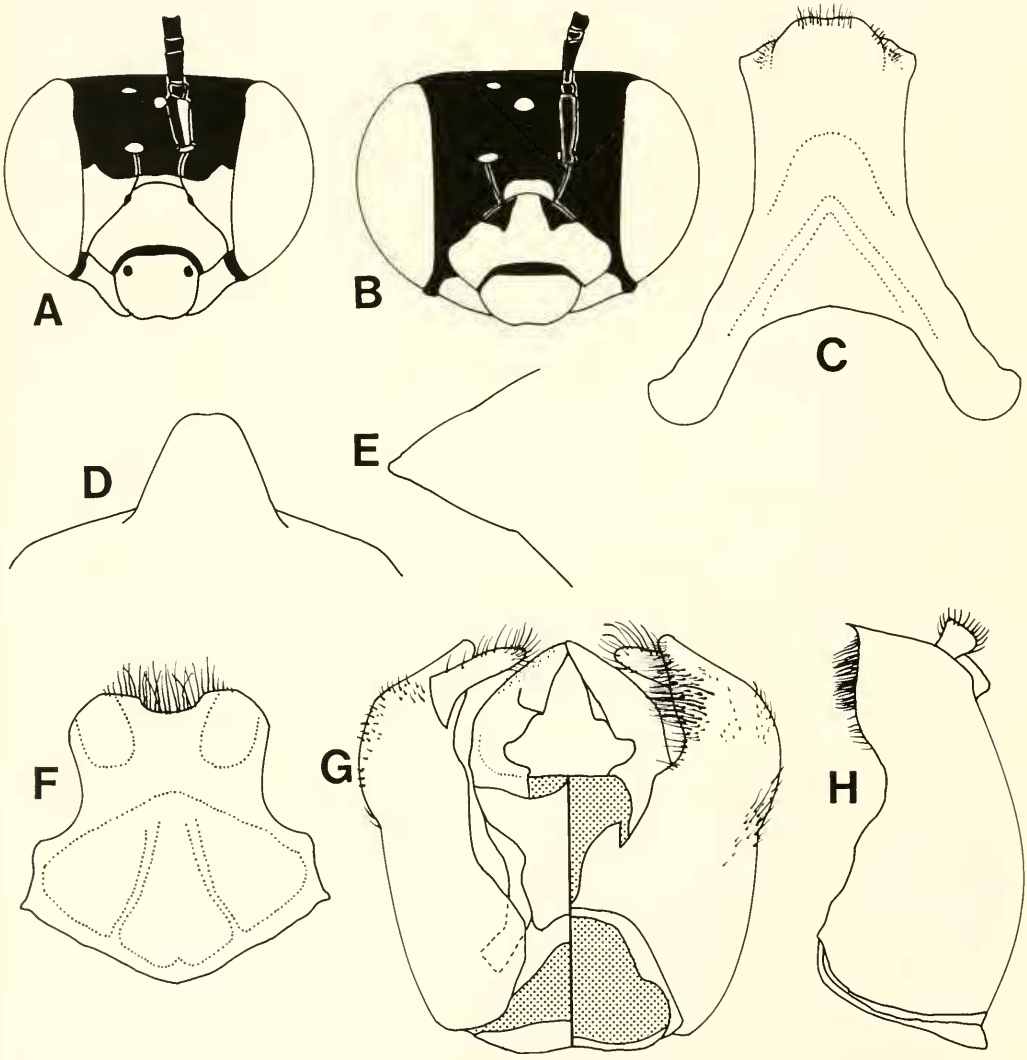


FIG. 48. *Anthophora (Heliophila) micheneri,* male holotype (except B which is head of allotype). A, B, Heads of holotype and allotype, frontal views. C, S7, ventral view. D, E, Apex of T7, dorsal and side views. F, S8, ventral view. G, H, Genital capsule, dorsoventral and side views.

ocellus to posterior ocellus 0.60 ocellocular distance; cu-v of hind wing equal to 0.67 length of second abscissa of M + Cu; vein M 2.3 times as long as second abscissa of M + Cu; jugal lobe about one-third as long as vannal lobe. S7, S8 and genital capsule as in Figs. 49c-f. *Coloration.* Brownish-black except facial marks dark yellow (yellow markings on holotype and paratype reddened, presumably due to cyanide exposure) and tarsi amber-brown. *Pubescence.* Lower half of head and thorax ochraceous, upper half red. Foreleg with ochraceous on outer surfaces and brown on inner surfaces; midleg with ochraceous hair except midbasitarsal brush and hairs on posterior margin dark-brown and lateral hair fringe on middistitarsus fuscous, inner surface of basitarsus brown; hind leg with ochraceous hair, but basitarsus dark brown on inner and outer surfaces (except apex ochraceous). T1 and T2 covered with long, shaggy orange hair; T3 and T4 on apical third with light orange-ochraceous hair and a few scattered dark hairs; basal two-thirds of T4 with short brown hair; T5 and T6 with mostly long, shaggy, dark hair, laterally with long,

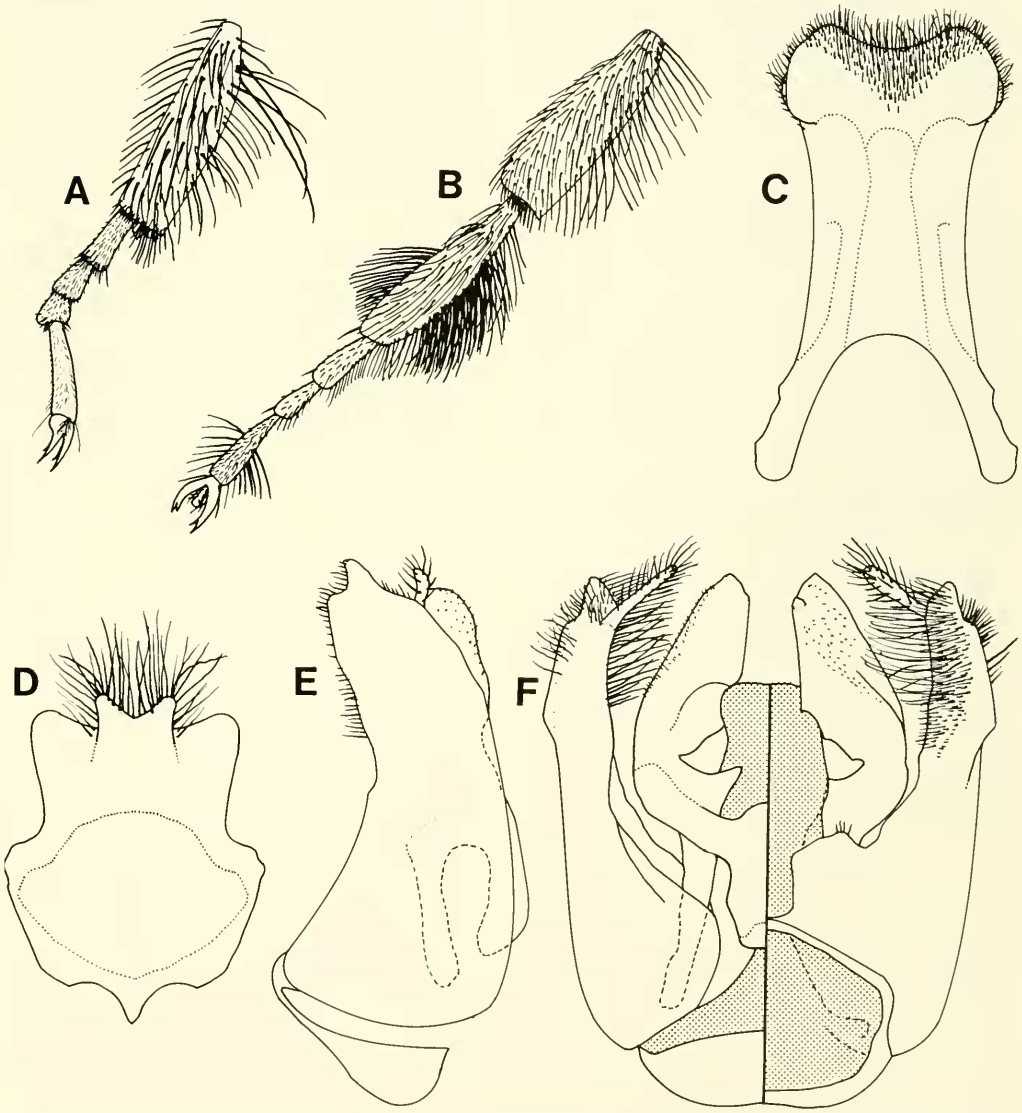


FIG. 49. *Anthophora (Pyganthophora) adamsorum,* male paratype. A, B, outer views of hind tarsus and mid tibia and tarsus. C, S7, ventral view. D, S8, ventral view. E, F, Genital capsule, side and dorsoventral views.

ochraceous hair; T7 with short orange hair; metasomal sterna with long, shaggy, ochraceous hair. *Punctation.* Punctures nearly contiguous to separated by 0.5 puncture-widths on clypeus and paraocular area; punctures much finer and nearly contiguous on rest of head. Thorax dull, punctures contiguous. Metasomal terga shiny, punctures separated by one to three puncture-widths.

Type material. Holotype male and 1 paratype male: China, Zhongguo, 200 km W. Kashgar [=Kashi, 39°29'N, 75°59'E], 17 June 1946, C. L. Li/ Museum Leiden, ex. coll. M. A. Lieftinck. Holotype [Leiden], paratype [Lawrence].

Etymology. This species is named for Ronald and Mary Ann Adams of Lawrence, Kansas, who contributed much to the emotional and spiritual well being of the author, thus enabling the completion of this study.

Amegilla (Micramegilla) canifronoides new species

Diagnosis. Face of female all black; hair mostly black but T1-T4 with white apical bands of hair, partially interrupted on T2 and completely so on T3-T4.

Description. Female: Length 11.5-12.6 mm; forewing length about 9 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes 1.2 length of eye; head wider than long; clypeus moderately protuberant, in profile .41 eye width; flagellomere 1 equal to combined length of next three flagellomeres, about equal to length of scape, and 1.5 times length of last flagellomere; flagellomeres 2-8 equal in length and as long as wide; distance between posterior ocelli equal to 1.2 ocellocular distance, distance from median ocellus to posterior ocellus equal to .44 ocellocular distance. Second submarginal cell receiving first recurrent vein slightly distal to midpoint; marginal cell length .78 distance from apex of cell to wing tip; cu-v of hind wing 1.87 times length of second abscissa of M+Cu; vein M 1.9 times length of second abscissa of M+Cu; jugal lobe .44 length of vannal lobe. *Coloration.* Black except coxae, trochanters, forefemur, anterior surface of midfemur, hind femur, posterior surface of hind tibia and S1-S2 Burnt Sienna. *Pubescence.* Hair on lower two-thirds of face white, upper third black with a few white intermixed. Scutum and metanotum black with some white intermixed; pleura black; propodeal area white; legs black except white patch on outer base of fore and midtibiae, and apicoposterior margin of hind tibia. Metasoma black with apical white bands on T1-T4, band on T1 of about uniform width, on T2 band widest submedially and narrower laterally and medially, on T3-T4 bands interrupted medially but widest submedially and narrow laterally; apical white bands appressed; black hair on T1-T3 appressed with few hairs raised as much as 45 degrees, black hair on T4-T5 raised as much as 60 degrees. *Punctation.* Labrum shiny, rugose-verrucose, rugae weakly and minutely microareolate; clypeus shiny, microareolate, ground between and within cavities weakly microareolate; rest of face shiny, alveolate with smaller cavities than on clypeus and ground between cavities smooth; scutum dull to weakly shiny, alveolate with bump in each alveolus, very near to verrucose, additionally weakly and minutely alveolate between and within larger alveoli, center of scutum less punctate; pleura somewhat more shiny than scutum though weakly so, alveolate like scutum though minute alveolation between large alveoli weaker; propodeal area verrucose. T1-T4 punctate except narrow apical margins, separation of punctures by 0.5-3.0 puncture-widths, T5-T6 more densely and coarsely punctate; metasomal sterna like T1-T4.

Type material. Female holotype: Cape Verde Islands, Brava, September 1898, 600-1000 m, collected by Leonardo Fea [Genoa]. Paratypes: Four females with the same data. One female collected in July at 0-300 m, and another female collected in August at 400-700 m, both on Brava. All paratypes deposited at Genoa except one at Lawrence.

Comments. This species is remarkably similar to *A. canifrons* from the Canary Islands but is smaller and the thoracic hairs are much darker. This species is at least endemic to the Cape Verde Islands, if not to Brava, and is the only species of *Amegilla* in the Cape Verde Islands with a black metasoma having bright white apical bands of hair on the terga.

Etymology: This species is so named after a similar looking species, *Amegilla canifrons* from the Canary Islands.

Amegilla (Micramegilla) capeverdensis new species

Diagnosis. Scopal hairs and hairs of metasoma Mars Yellow (color like that of *A. africana* and *capensis*); face of female all black; thorax with pale hair mixed with some black hair on scutum.

Description. Female: Length 9.7-11.2 mm; forewing length 7.2-7.8 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes 1.1 length of eye; head wider than long; clypeus weakly protuberant, in profile .27 eye width; flagellomere 1 equal to combined length of next 2.6 flagellomeres together, .77 as long as scape (excluding basal bulb), and 1.4 times length of last flagellomere; flagellomeres 2-9 equal in length, 1.1 times as long as wide; distance between posterior ocelli equal to 1.3 ocellocular distance, distance of median ocellus to posterior ocellus equal to .66 ocellocular distance. Second submarginal cell receiving first recurrent vein distal to midpoint; marginal cell length .81 distance from apex of cell to wing tip; cu-v of hind wing 1.43 times length of second abscissa of M+Cu, vein M 2.8 times length of second abscissa of M+Cu; jugal lobe .36 length of vannal lobe. *Coloration.* Face black except apex of clypeus, labrum, and basal two-thirds of mandi-

ble Burnt Sienna; mouthparts and lateral surface of flagellum Cinnamon- Rufous. Thorax black, legs and wing veins Cinnamon-Rufous, wings clear. Metasomal terga and sterna with visible portions of discs black, margins Cinnamon-Rufous. *Pubescence.* Hair on face pale but mixed with some black on vertex, hair densely spaced obscuring paraocular area but rest of facial surface visible. Scutum with pale and black hair intermixed; pleura almost all pale with occasionally only a few black hairs; thoracic sterna, propodeal area, mid and hind coxae, trochanters and femora pale; forefemur with long Fuscous hair; tibiae and tarsi Mars Yellow. Metasomal terga Mars Yellow with lighter apical bands of Warm Buff except T5 with a dense median patch of Fuscous surrounding base of pygidial plate, hair on terga appressed with some semi-erect hair inclined at most as a 45° angle; metasomal sterna Mars Yellow. *Punctation.* Face weakly shining; labrum shiny, rugose, rugae smooth; clypeus coarsely areolate-verrucose, spaces again minutely microareolate; rest of face somewhat more shiny than clypeus, less coarsely microareolate, spaces smooth. Scutum weakly shining, less dull in center, densely punctate at margins, punctures contiguous to .5 puncture-widths apart, but in middle of scutum punctures separated by 0.5-6.0 puncture-widths, ground between punctures finely alveolate; pleura, scutellum and metanotum weakly shining, densely punctate, punctures contiguous to .5 puncture-widths apart, ground between punctures finely microareolate; propodeal area dull, finely alveolate. T1-T4 shiny, punctate except apical margin, separation of punctures 0.5-3.0 puncture-widths, ground between punctures minutely microareolate; T5-T6 coarsely areolate, ground between punctures minutely microareolate; sterna shiny, punctate, separation of punctures 1.0-5.0 puncture-widths, apical margins and gradular area impunctate but these areas as well as ground between punctures minutely alveolate, alveoli often in rows, appearing striate.

Type material. Female holotype: Cape Verde Islands, Boa Vista, December 1897, collected by Leonardo Fea [Genoa]. Paratypes: Twelve females with same data and eight additional females collected in February 1898. All paratypes deposited at Genoa except two paratypes at Lawrence.

Comments. This species is similar in appearance to *A. africana* and *capensis* but is much smaller in size. Besides being presumably endemic to the Cape Verde Islands and being presumably the only yellow *Amegilla* there, it is the only yellow species of *Amegilla* with an all black female face.

Etymology: This species is named after the Cape Verde Islands.

Amegilla (Aframegilla) robinae new species

Diagnosis. Face of male with pale yellow (Aniline Yellow) integumental markings as in Figure 50f; T1-T5 with apical hair bands pale Russian Blue; terminalia as in Figures 50a-d.

Description. Male: Length 13 mm; forewing length 9.2 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes .8 length of eye; malar space linear; head wider than long; clypeus protuberant, in profile .6 width of eye; galea short, reaching slightly posterior to forecoxa; flagellomere 1 equal to combined length of next 2.7 flagellomeres; .8 as long as scape (excluding basal bulb) and 1.5 times as long as last flagellomere; flagellomeres 2-10 about equal in length and about 0.9 times as long as wide; distance between posterior ocelli equal to 1.1 ocellocular distance; distance from median ocellus to posterior ocellus .44 ocellocular distance. Marginal cell length equal to distance from apex of marginal cell to wing tip; vein cu-v of hind wing .8 length of second abscissa of M + Cu; vein M 2.9 times as long as second abscissa of M + Cu; jugal lobe a little less than half length of vannal lobe. S5 broadly and shallowly emarginate, S6 shallowly emarginate apicomedially (Fig. 50e) but apical margin only slightly deflexed ventrally otherwise disc gently convex; S7 apically round, disc with well developed lateral tooth on basal half (Fig. 50d); S8 apically rounded (Fig. 50c); T7 apparently bidentate medioapically but margin between bases of teeth weakly produced medially appearing weakly tridentate (Fig. 50e), without median longitudinal ridge; penis valves small; gonocoxite with well developed inner lobe; genital capsule from dorsal view rounded in outline (Figs. 50a, b). *Coloration.* Black except integumental facial marks Aniline Yellow (Fig. 50f), mouthparts, tegula and S1-S2 Burnt Sienna. *Pubescence.* Face with pale hair except vertex Buckthorn Brown. Thorax Buckthorn Brown with a few black hairs intermixed, sterna pale; coxa pale; foreleg black except inner surface of tarsus Burnt Sienna, outer surface pale; midleg like foreleg except only pale on outer surface of tibia and basal half of basitarsus; hind leg like foreleg except only pale on outer surface of tibia. T1- T5 with apical bands pale Russian Blue with a few scattered dark hairs; rest black. *Punctation.* Clypeus dull, coarsely punctate, punctures separated by 0.5-1.0 puncture-width, ground between punctures coriarious-areolate; labrum shiny, rugulose-lacunose, ground between pits alveolate; paraocular areas shiny, rugulose-lacunose, ground between pits weakly microareolate; supraclypeal area to posterior ocelli coarsely, densely punctate, punctures separated by 1 puncture-width to contiguous. Scutum and scutellum weakly shining, coarsely punctate, punctures separated by 0.5 puncture-width to contiguous; pleura shiny, coarsely punctate, punctures separated by 1.0 puncture-width to contiguous; metanotum and propodeum dull, finely punctate, punctures contiguous. T1-T5 dull, puncticulate, ground between punctures microareolate, apical margin impunctate but microareolate; S1-S2 with

scattered coarse punctures, S3-S6 coarsely punctate, ground between punctures microareolate.

Type Material. Holotype male: Sierra Leone, with no collector or collection date [Genoa].

Comments. A. robinae is the only species of the subgenus *Aframegilla* which has blue metasomal bands of hair and yellow markings on the face of the male. The distinctive shape of the male S7 which has a large lateral tooth midway, the male S8 and the genital capsule (Figs. 50a-d) will separate it from any *Amegilla.*

Etymology. This species is named in honor of my wife Robin, who is not a quantity but a quality collector.

Amegilla (Aframegilla) elsei new species

Diagnosis. Face of male with white integumental markings as in Figure 50l; T1-T5 with apical hair bands pale Russian Blue; terminalia as in Figures 50g-j.

Description. Male: Length 14 mm; forewing length 11.4 mm. *Structure.* Inner orbits diverging slightly above; shortest distance between eyes .8 length of eye; malar space linear; head wider than long; clypeus protuberant, in profile .6 width of eye; galea short, reaching slightly posterior to forecoxa; flagellomere 1 equal to combined length of next 2.3 flagellomeres; .76 as long as scape (excluding basal bulb) and about as long as last flagellomere; flagellomeres 2-10 about equal in length and about 1.26 times as long as wide; distance between posterior ocelli equal to 1.19 ocellocular distance, distance from median ocellus to posterior ocellus .58 ocellocular distance. Marginal cell length equal to 1.05 distance from apex of marginal cell to wing tip; vein cu-v of hind wing .8 length of second abscissa of M + Cu; vein M 2.4 times as long as second abscissa of M + Cu; jugal lobe .4 length of vannal lobe. S5 broadly and shallowly emarginate; S6 shallowly emarginate medioapically, apical margin strongly flexed ventrad (Fig. 50k), T7 medioapically bidentate, margin between teeth simple but with median longitudinal ridge extending anteriorly; S7 apically angulate laterally (Fig. 50j); S8 with lateral margin concave not apically converging (Fig. 50i); penis valves small; gonocoxite with well developed inner lobe; genital capsule somewhat rounded in outline from dorsal view (Figs. 50g, h). *Coloration.* Black except integumental facial marks white (Fig. 50l), mouthparts and foretarsus Burnt Sienna. *Pubescence.* Face with white and black hair from clypeus to vertex; labrum, mandibles and gena with white hair. Scutum, upper half of pleura and scutellum with black and white hair, rest of thorax white; foreleg white with a few black hairs on outer surface of tibia, inner surface of tarsus Burnt Sienna; midleg with femur black, tibia on outer surface white with a few scattered black hairs, rest of midleg black; hind leg similar to midleg except outer surface of tibia all white. T1-T5 with apical bands of appressed pale Russian Blue hair, bands on T1 and T2 narrower, on T3-T5 blue hair scattered over visible portions of terga, T1-T5 laterally with dense white hair, T6-T7 with black hair; S3-S5 with sparse white hair laterally. *Punctation.* Labrum shiny, shallowly rugose-lacunose, ground between pits weakly microareolate; clypeus dull but weakly shining laterally, densely punctate, ground between punctures coarsely microareolate; paraocular and supraclypeal area to vertex puncticulate, ground between punctures weakly microareolate. Scutum weakly shining, densely punctate, punctures separated by 1 puncture-width to contiguous, ground between punctures weakly microareolate; pleura and scutellum weakly shining, densely punctate, punctures separate by 0.5-2.0 puncture-widths, ground between punctures coarsely microareolate; propodeum and metanotum punctulate, dull. Metasoma puncticulate, ground between punctures aveolate.

Type Material. Holotype male: Angola (A37), 5 mi. (8 km) NE. Negola, collected on 25 March, 1972 on the Southern African Expedition of the British Museum (Natural History) 1972-1 [London].

Comments. This species is closely related to *A. caerulea* and *aerizusa* from which it is separated by the lighter blue hair, the shape of the male S7, S8 and genital capsule (Figs. 50g-j). The members of this species group are difficult to separate without comparing male genitalia and associated sterna.

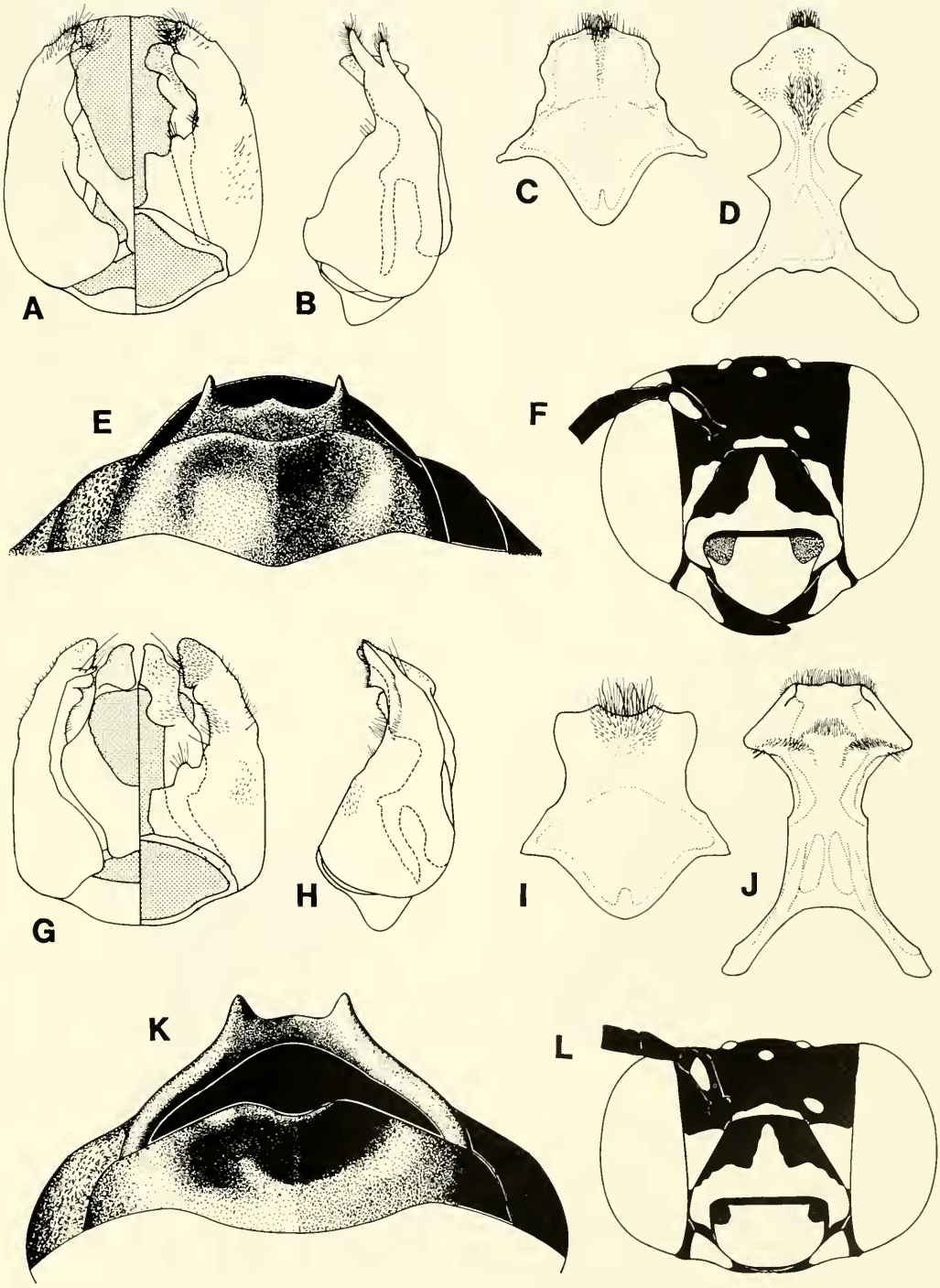
Etymology. This species is named in honor of George R. Else, curator of Apoidea, British Museum (Natural History), for his valuable assistance in this study and for his admirable devotion to and enthusiasm for bee systematics.

Amegilla (Micramegilla) modestoides new species

Diagnosis. Male and female with all black face; hair on face and thorax pale with scattered black hairs; metasoma all black except for pale hairs on T1.

Description. Male: Length 10.0-12.3 mm; forewing length 7.8-8.3 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes .85 length of eye; head wider than long; clypeus moderately protuberant, in profile .47 eye width; flagellomere 1 equal to combined length of next 1.9 flagellomeres together, .63 as long as scape

FIG. 50. New species of *Amegilla (Aframegilla),* males. A-F, *A. (A.) robinae;* G-L, *A. (A.) elsei.* A, B, Genital capsule, dorsoventral and side views. C, D, S8 and S7, ventral views. E, Apex of S6 and T7 (hair omitted), ventral view. F, Head. G, H, Genital capsule, dorsoventral and side views. I, J, S8 and S7, ventral views. K, Apices of S6 and T7 (hair omitted), ventral view. L, Head.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(excluding basal bulb), and equal in length to last flagellomere; flagellomeres 2-10 equal in length and 1.2 times as long as wide; distance between posterior ocelli equal to 1.2 ocellocular distance, distance from median ocellus to posterior ocellus equal to .62 ocellocular distance. Second submarginal cell receiving first recurrent vein slightly distal to midpoint; marginal cell length .88 distance from apex of cell to wing tip; cu-v of hind wing 1.3 times length of second abscissa of M+Cu, vein M 2.2 times length of second abscissa of M+Cu; jugal lobe .4 length of vannal lobe; S6 with weak apicomedian emargination; apex of T7 trilobed such that median tooth is weakly developed and lateral teeth well developed; S7-S8 as in Figures 51c, d, apex of S7 with weakly developed lateral lobes, genital capsule as in Figures 51a, b. *Coloration.* Black except mandi-

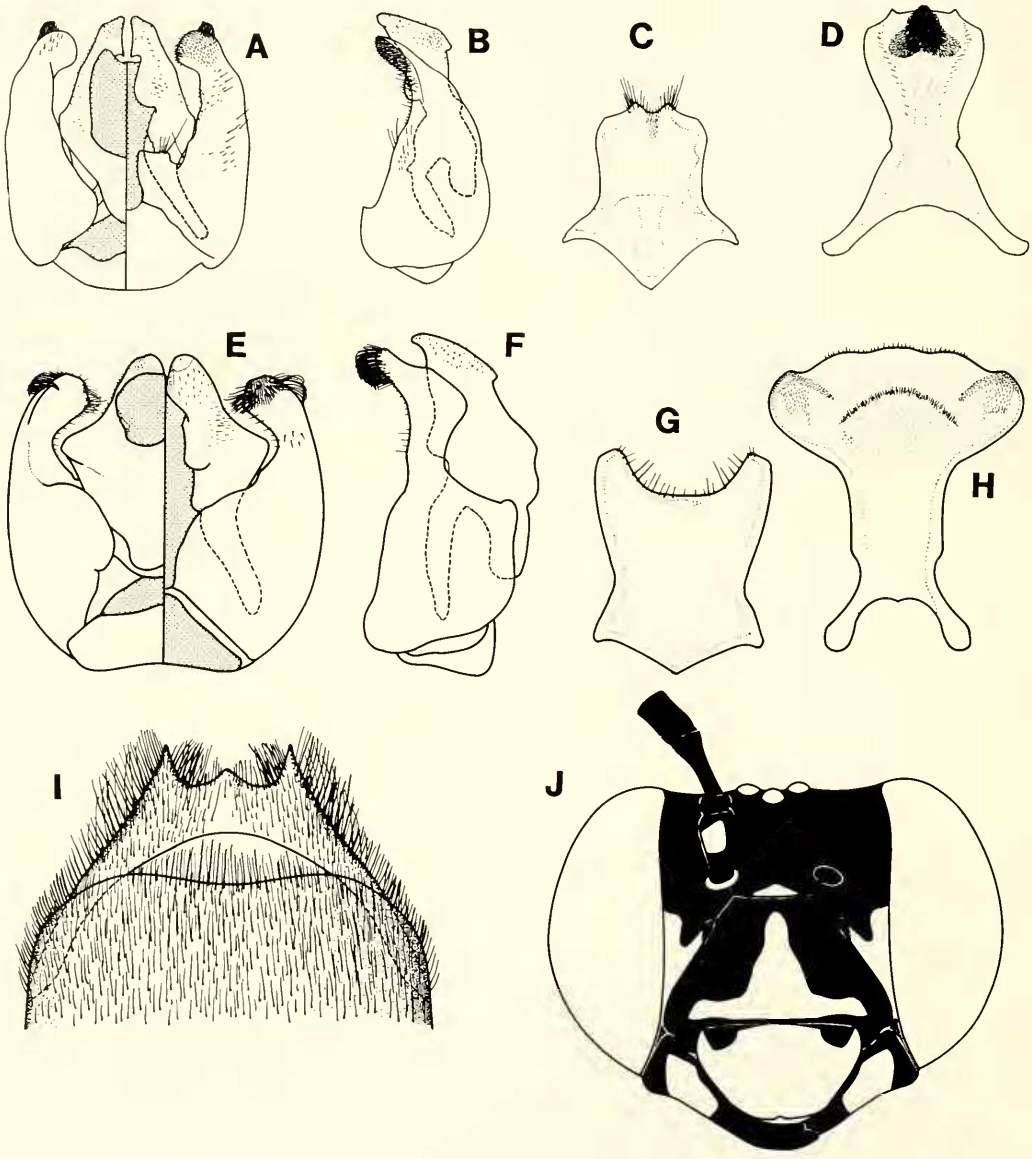

FIG. 51. New species of *Amegilla,* males, subgenera *Micramegilla* and *Glossamegilla.* A-D, *A. (M.) modestoides;* E-J, *A. (G.) lieftincki.* A, B, Genital capsule, dorsoventral and side views. C, D, S8 and S7, ventral views. E, F, Genital capsule, dorsoventral and side views. G, H, S8 and S7, ventral views. I, S6 and T7, ventral view. J, Head.

bles, posterior surfaces of legs and wing veins Claret Brown, wings slightly infuscated, not clear. *Pubescence.* Face, including gena, on lower two-thirds covered with white hair such that surface is obscured but surface of labrum visible, white hair with some black around vertex of head; scutum and upper fourth of pleura pale with black hair intermixed, rest of pleura and thoracic sterna Fuscous; legs Fuscous except outer surfaces of tibiae light Orange-Yellow, apices of mid and hind tibiae with white hair; propodeal area and T1 covered with long pale hair, rest of metasoma black. *Punctation.* Face weakly shiny; clypeus, paraocular and supraclypeal areas microareolate; labrum areolate-rugose, rugae minutely microareolate; vertex punctate, punctures separate by 0.5-10.0 puncture-widths; scutum dull, alveolate and within and between alveoli minutely alveolate; pleura and scutellum dull, obscurely variolate, ground between indentations minutely microareolate; propodeum dull, posterior two-thirds microareolate, anterior third minutely microareolate; metasoma dull, punctate, punctures separated by 1.0-6.0 puncture-widths, ground between punctures weakly imbricate, with narrow apical impunctate margins.

Female: Length 10.7-13.2 mm, forewing length 7.8-9.2 mm. Agrees with male description except for sex-limited characters and as follows: *Structure.* Flagellomere 1 equal to combined length of next three flagellomeres together, .78 as long as scape (excluding basal bulb), and 1.6 times as long as last flagellomere. *Pubescence.* Legs black to Fuscous, with pale hair on outer basal surface of midtibia, and posterior to pencillus on hind tibia; scopal hair Fuscous to Cinnamon-Rufous; T1, in addition to covering of long pale hair, with narrow band of appressed pale hair on apical margin, sometimes T2 and T3 with similar appressed bands of hair but interrupted medially.

Type material. Male holotype: Cape Verde Islands, São Tiago, Orgãos Grandes, May 1898, collected by Leonardo Fea; female allotype with same data [Genoa]. Paratypes: With same data except 2 females collected in March, 18 females and 1 male collected in April, 19 females and 3 males collected in May. All paratypes deposited at Genoa except two males and two females at Lawrence.

Comments. This species is similar in appearance to *A. godofredi* but is smaller in size and the scopa is pale, not orange. Besides being presumably endemic to the Cape Verde Islands, it is the only *Amegilla* which has a black face in both sexes and a black body with pale hair on the head, thorax and T1.

Etymology: This species is named after a similar looking species, *Amegilla modesta* (Smith) (=*A. godofredi* Dours), which is also endemic to the Cape Verde Islands.

Amegilla (Glossamegilla) lieftincki new species

Diagnosis. Female with Beryl Blue mixed with black and white hair on head, thorax, outer surfaces of fore and midtibiae, and apical margins of T1-T4; face of female with only small triangular pale mark on apicomedian half of clypeus; Beryl Blue pubescence of male only on apical margins of T1-T5 and hairs scattered near wing base and on outer surfaces of hind tibia, T7 of male with apicomedian trilobed margin (Fig. 51i), S7 of male with apical half much expanded, apodemes small (Fig. 51h), S8 of male broadly and deeply emarginate (Fig. 51g).

Description. Male: Length 14.6 mm; forewing length 11.2 mm. *Structure.* Inner orbits almost parallel (Fig. 51j); shortest distance between eyes .8 length of eye; malar space linear; head wider than long; clypeus protuberant, in profile .6 width of eye; galea in repose reaching posterior edge of hind coxa; flagellomere 1 equal to combined length of next 2.3 flagellomeres, 1.5 as long as scape (excluding basal bulb) and 1.4 times as long as last flagellomere, flagellomeres 2-10 about equal in length and 1.3 times as long as wide; distance between posterior ocelli equal to 1.3 ocellocular distance; distance from median ocellus to posterior ocellus .2 ocellocular distance. Marginal cell length 1.1 times distance from apex of marginal cell to wing tip; cu-v of hind wing subequal in length to second abscissa of M + Cu; vein M 3.1 times as long as second abscissa of M + Cu; jugal lobe about one-third length of vannal lobe. T7 with apicomedian margin trilobed (Fig. 51i); S6 with weak apicomedian emargination (Fig. 51i); S7 with apical half much expanded (Fig. 51h); S8 broadly and deeply emarginate, disc constricted in basal two-fifths (Fig. 51g); gonocoxite apically simple from dorsal or ventral view (Fig. 51e), in profile basally constricted (Fig. 51f); bridge of penis valve long and wide (Fig. 51e). *Coloration.* Black except pale integumental facial marks (Fig. 51j), coxae, trochanters, femora, and metasomal sterna Burnt Sienna; wing infuscated. *Pubescence.* Face with mixture of black and white hair; gena with white hair; hair on scutum black with a little white hair intermixed, ratio of white to black hair gradually increasing ventrally on pleura to thoracic sterna which is nearly all white, propodeum laterally with long white hair; foreleg with white hair on coxa, with black and white hair on outer surface of tibia and tarsus, femur and inner surfaces of tibia with dark hair, inner surface of tarsus Burnt Sienna; midleg with white hair on coxa, outer surface of tibia and apex of femur with black and white hair, rest of midleg with dark hair; coxa and trochanter of hind leg with white hair; outer surface of tibia with white, black and Beryl Blue hair intermixed, its length about equal to length of scape but long at apex where it is about equal to length of mandible, rest of hind leg with black hair; visible portions of T2-T5 with black hair on basal two-thirds, apical margin with transverse band of pale and Beryl Blue hair intermixed; S1-S4 with pale hair, S5-S6 with dark hair. *Punctation.* Clypeus dull, coarsely punctate, punctures

deep and 0.5-2.0 punture-widths apart, ground between punctures microareolate; labrum somewhat shiny, punctures shallow, nearly confluent, ground between punctures microareolate; paraocular areas shiny, with coarse shallow punctures, ground between punctures finely microareolate; supraclypeal area shiny, with deep coarse nearly confluent punctures; vertex shiny, with coarse to fine punctation, punctures confluent to 4 puncture-widths apart, ground between punctures smooth; scutum weakly shiny with coarse punctures confluent to .5 puncture-widths apart, ground between punctures smooth; pleura shiny, punctation finer than scutum but similar; T1-T4 with visible portions (excluding apical margin bearing pale hair band) dull, coarsely puncticulate, ground between punctures finely microareolate, T5-T7 weakly shining, punctation like preceeding terga except ground between punctures more coarsely microareolate; S1-S3 shiny, with scattered coarse to shallow punctation, ground between punctures microareolate, S4-S6 shiny, punctation nearly confluent.

Female. Length 17 mm, forewing length 13.4 mm. Agrees with description of male except for sex-limited characters and as follows: *Structure.* Flagellomere 1 equal to combined length of next 3.4 flagellomeres, 1.6 as long as scape (excluding basal bulb) and 1.9 as long as last flagellomere; distance between posterior ocelli equal to 1.4 ocellocular distance; distance from median ocellus to posterior ocellus .13 ocellocular distance. *Coloration.* Black except small triangular pale integumental mark on median half of clypeus, legs Burnt Sienna to almost black. *Pubescence.* Facial hair a mixture of black, white, and Beryl Blue; gena with white and Beryl Blue hair on upper half, lower half with white hair; scutum and pleura with mixture of black, white, and Beryl Blue hair; propodeal area with white and black hair; fore and midcoxae with white and black hair, hind coxa with white hair; fore and midtibiae with black and Beryl Blue hair; rest of hair on legs black; T1-T4 like that of male T2-T5; T5-T6 and sterna with black hair. *Punctation.* Thorax somewhat shining, punctures coarse, nearly confluent to .5 puncture-width separation; T5-T6 weakly shining.

Type material. Holotype male: Malaysia, Perak, Larut Hills, 3000-3700 feet (914-1128 m), 16 February 1932. Allotype female: Malaysia, Pahang, Cameron Highlands, Jasar Mt., 5500 feet (1676 m), 25 June 1935. Both holotype and allotype were by H. M. Pendlebury [Leiden]. Paratypes: All from Malaysia: (1 male) Pahang, Fraser's Hill, 4200 feet (1280 m), 22 July 1936; (1 male) Pahang, Cameron Highlands, Tanah Rata, 4800-5000 feet (1463-1524 m), 16 July 1938; (1 male) Perak, Larut Hills, 4500 feet (1371 m), 20 February 1932; (1 male) Pahang, Cameron Highlands, Tanah Rata to Padang, 4800 feet, 1 June 1931; (1 male) Pahang, Cameron Highlands, Tanah Rata to Padang, 3500-4500 feet (1067-1371 m), 17 May 1939; (1 female) Pahang, Cameron Highlands, Pendat Mt., 5170 feet (1576 m), 25 July 1938; (1 female) Pahang, Cameron Highlands, Tanah Rata, 31 January 1940 (H. T. Pagden) on *Crotalaria;* and (1 female) Pahang, Fraser's Hill, 4600 feet (1403 m), 5 June 1941 (H. T. Pagden). Except as otherwise indicated all specimens were collected by H. M. Pendlebury. All paratypes are deposited at Leiden except two males and two females each at Lawrence.

Comments. This striking species is the only known *Glossamegilla* with blue hair, not unlike that of many *Zonamegilla. A. lieftincki* is easily separated from any species of *Zonamegilla,* however, by the presence of metallic blue hair on the thorax as well as the metasoma, by the larger size and by the almost black female face and greatly reduced pale clypeal markings of the male.

Etymology. This species is named in recognition of my late good friend Dr. Maus A. Lieftinck, for his many excellent contributions to anthophorine systematics.

Amegilla nonconforma new species

Diagnosis. Face all black, without pale integumental facial marks. Labrum with apically converging ridges forming a median plate (Fig. 52d); in profile clypeal protuberance 0.45 width of eye; mentum without anterior tooth on basal third; very similar in appearance to *Amegilla paradoxa* n. sp. (see *Diagnosis* of that species).

Description. Female: Length 15 mm; forewing length 11.8 mm. *Structure.* Inner orbits slightly diverging above; shortest distance between eyes 0.87 length of eye; malar space linear; head wider than long; face flat, clypeal protuberance in profile 0.45 width of eye; mandible with subapical tooth; mentum without anterior tooth on basal third; flagellomere 1 equal to combined length of next 3.5 flagellomeres, 0.91 as long as scape (excluding basal bulb) and 2.1 times as long as last flagellomere; flagellomeres 2-9 about equal in length and about as long as wide; distance between posterior ocelli equal to 1.26 ocellocular distance; distance from median ocellus to posterior ocellus 0.42 ocellocular distance; clypeus with apicomedian depressed triangular area, more shiny than rest of clypeus (Fig. 52d); labrum with apically converging ridges forming a median plate (Fig. 52d). Marginal cell length equal to 0.83 distance from apex of cell to wing tip; vein cu-v of hind wing about equal to length of second abscissa of M + Cu; vein M 3.43 times as long as second abscissa of M + Cu; jugal lobe 0.44 length of vannal lobe. *Coloration.* Black except metasomal sterna reddish brown. *Pubescence.* Like *Amegilla paradoxa* except facial hair all white and mixed with black on vertex. Legs all black except outer surface of fore tibia with black and white; fore femur all white except for a few dark hairs anteriorly and base of mid femur with a few

white hairs anteriorly. T1 with white hair on basal two- thirds, T2-T3 all black, S2-S5 with apicomedian band of short orange hair, in addition S3-S5 laterally with white. *Punctation.* Like *Amegilla paradoxa* except face dull, although shiny near posterior ocelli and apicomedian triangular area of clypeus.

Type material. Holotype female: Malawi, Rumpi, Northern Dist., 12 April 1967, C. D. Michener [Lawrence].

Comments. This species is so strange that without the male I am uncertain as to what subgenus it may be in. It possibly is an *Aframegilla.* It is easily recognized by the strangely punctured face and lack of a tooth on the mentum, which suggest *Anthophora,* yet it lacks arolia and has a single basistipital process, features that place it in *Amegilla.* The color and pattern of the pubescence make it look very similar to *Amegilla (Megamegilla) albocaudata* (Dours) and *A. (M.) paradoxa* n. sp., yet the structure of the labrum and all black face easily separate it from those two.

Etymology. This species is so named because it is the only known species of *Amegilla* without an anterior tooth on the basal third of the mentum.

Anthophora (Megamegilla) paradoxa new species

Diagnosis. Clypeus of female completely flat medially, with short dark bristles. Upper half of thorax with red hair, lower half white; T1-T3 with all black; T4 with white hair on apical half; T5 covered with white except black apicomedially; legs essentially all black except some white hair on outer surfaces of tibiae.

Description. Female: Length 17.6 mm; forewing length 13.8 mm. *Structure.* Inner orbits more or less parallel; shortest distance between eyes 0.84 length of eye; malar space linear; head wider than long; clypeal protuberance in profile 0.6 width of eye; galea in repose reaches anterior margin of midcoxa; mandible with subapical tooth; flagellomere 1 equal to combined length of next 3.8 flagellomeres, 1.17 as long as scape (excluding basal bulb) and 2.1 times as long as last flagellomere; flagellomeres 2-9 about equal in length and about 0.87 times as long as wide; distance between posterior ocelli equal to 1.22 ocellocular distance, distance from median ocellus to posterior ocellus 0.52 ocellocular distance. Marginal cell length equal to 0.78 distance from apex of cell

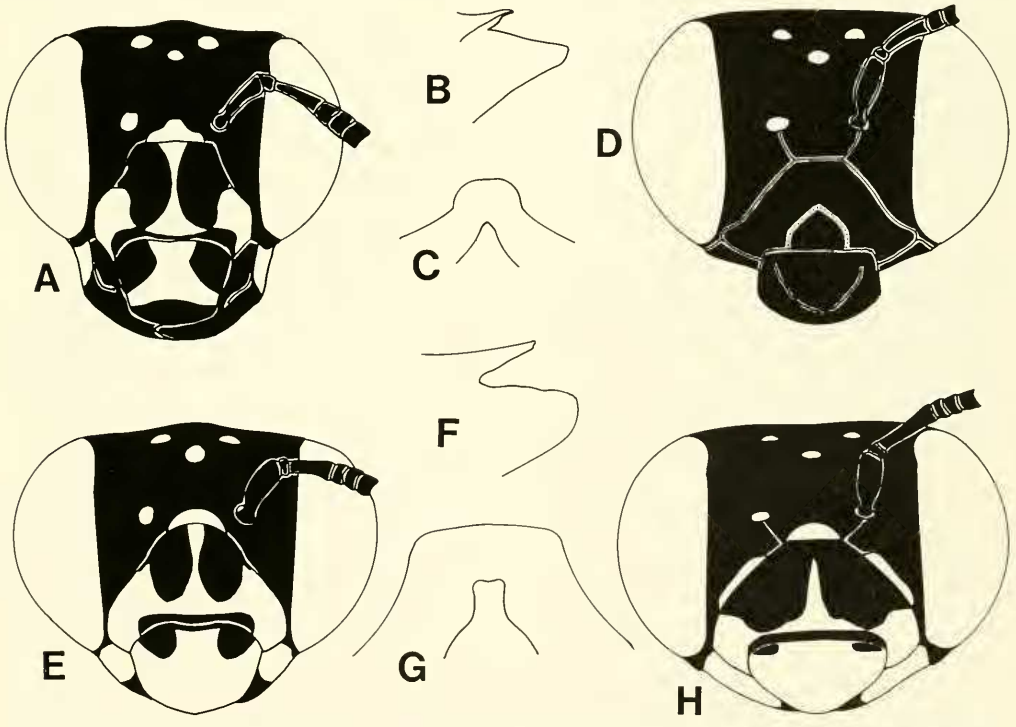

FIG. 52. New species of *Amegilla.* A-C, *A. (Asaropoda) houstoni,* female holotype; head, frontal view; apex of S6, side and ventral views. D, *A. nonconforma,* female holotype, head, frontal view. E-G, *A. (Asaropoda) epaphrodita,* female holotype; head, frontal view; apex of S6, side and ventral views. H, *A. (Megamegilla) paradoxa,* female holotype, head, frontal view.

to wing tip; vein cu-v of hind wing 1.1 length of second abscissa of M + Cu; vein M 3.7 times as long as second abscissa of M + Cu; jugal lobe 0.46 length of vannal lobe. Clypeus and supraclypeal area completely flat medially. *Coloration.* Black except integumental facial marks creamy white (Fig. 52h); tip of mandible and galea reddish brown. Legs reddish black. Metasomal sterna reddish brown. *Pubescence.* Head with mixture of white and black hair but pure white on occiput, gena, mandible and narrowly along paraocular margin; supraclypeal area, clypeus and labrum with fine white hairs, mostly hooked ventrad at apices; in addition supraclypeal area and clypeus with short, stout, straight, dark bristles; labrum basomedially with fine, apically hooked, light brown hairs. Thorax on upper half orange, lower half white; legs with mostly black except mixed with white on outer surfaces of foretibia and foretarsus; midtibia with small patch of white on outer basal surface. T1-T3 all black; T4 on apical half with appressed white hair and a few scattered, semierect dark hairs; T5 with erect white hair laterally but appressed medially, in addition scattered, semierect, dark hair basomedially and a dense black patch of hair apicomedially; T6 all dark except red brown apicomedially; metasomal sterna with dark hair except a fine, short apical fringe on S1, a few hairs apicomedially and apicolaterally on S2, a dense lateral patch on S3-S4 and a few hairs laterally on S5, white. *Punctation.* Almost contiguous on face but weakly shining in interspaces. Thorax shining but surface almost completely obscured by hair. Metasomal terga weakly shining, but sterna more glabrous.

Type material. Holotype female: Malawi, Rumpi, Northern Dist., 12 April 1967, C. D. Michener [Lawrence].

Comments. This species resembles *Amegilla (Megamegilla) albocaudata* (Dours) but can easily be separated from it and any other *Amegilla* species by the strangely flattened clypeal and supraclypeal areas which, in addition, have fine, white, apically hooked hairs mixed with short, stout dark bristles. This type of facial modification is reminiscent of some *Anthophora (Mystacanthophora)* species (see variable 6 in Table 1) and is the first such modification found among anthophorine bees in the Old World. Such a modification has been seen also in an undescribed genus of Eucerini related to *Eucara* in Africa.

Etymology. This species is named for the strangely modified clypeal and supraclypeal area.

Amegilla (Asaropoda) epaphrodita new species

Diagnosis. Head with white (lower half) to light orange (upper half) hair; thorax with black (lower half) and orange (upper half) hair; T1-T3 all black (except T3 with small apicolateral white patch of hair); T4-T6 all white except T6 with apicomedian patch of black hair; S6 with bluntly emarginate subapical tooth (Figs. 52f, g).

Description. Female: Length 15.4-16.2 mm; forewing length about 12 mm. Inner orbits diverging above; shortest distance between eyes 0.83 frontal length of eye; head wider than long; clypeal protuberance in profile 0.59 eye width; mandible with subapical tooth; flagellomere 1 equal to combined length of next 3.1 flagellomeres and 0.91 as long as scape (excluding basal bulb); flagellomere 2 equal to 0.9 length of flagellomere 3; flagellomeres 3-9 gradually increasing in length; last flagellomere equal to 0.71 length of flagellomere 1; distance between posterior ocelli 1.1 ocellocular distance; distance from median ocellus to posterior ocellus equal to 0.47 ocellocular distance. Marginal cell length equal to 0.90 distance from apex of cell to wing tip; cu-v of hind wing about equal to length of second abscissa of M + Cu; vein M 3.95 times as long as second abscissa of M + Cu; jugal lobe 0.47 length of vannal lobe. S6 with large, bluntly emarginate, posteriorly projecting, subapical tooth (Figs. 52f, g). *Coloration.* Black except antenna reddish brown, facial marks yellow (Fig. 52e); median apical margin of clypeus, lateral basal marks of labrum, galea, coxae, trochanters, femora and S1-S4 reddish brown. *Pubescence.* Dense on head and thorax. Lower half to two-thirds of head with white, upper half to one-third orange. Lower half of thorax black (with a few white hairs intermixed), upper half orange; foreleg with coxa, trochanter, femur and tibia having long hair anteriorly but inner surface of femur and inner and anterior surface of tibia with dark hair. T1-T3 black (T3 with appressed white patch apicolaterally); T4-T5 with appressed white hair and scattered dark hairs (apicomedian margin of T4 bare [0.23 mm wide]), T5 also with apicomedian, dense patch of black hair; metasomal sterna all black except for a lateral patches of white hair on S3 and S4. *Punctation.* Face shiny, especially on median yellow mark of clypeus; punctures separated by 0.5-3.0 puncture-widths. Thorax dull, punctures contiguous. Metasomal terga shiny, punctures nearly contiguous to 3 puncture-widths apart.

Type material. Female holotype: Australia, Northern Territory, 15 km E. Mt. Cahill, 12°52'S, 132°50'E, 6-9 March 1978, N. T., M. S. Upton [Canberra]. Paratypes: Four females from Northern Territory, Burnside, Brock's Creek (3 females) 15 February 1932, (1 female) 14 February 1932, T. G. Campbell [3 Canberra], [1 Lawrence].

Comments. The distinctive color pattern given in the *Diagnosis* along with the subapical tooth on S6 will easily separate this species from any other in Australia. The facial markings (Fig. 52e) as well as the pubescent pattern on the metasomal terga will separate *A. epaphrodita* (from the Northern Territory) from the closely related *A. houstoni* (from Western Australia).

Etymology. This species is so named (*epaphroditos,* Gr., lovely, charming) because of its beautiful color pattern and dense, carpet-like pubescence.

Amegilla (Asaropoda) houstoni **new species**

Diagnosis: Similar to *A. epaphrodita* but facial marks differ (Fig. 52a) and T2 and T3 with well developed apical bands of appressed white hair; vein M 4.67 times as long as second abscissa of M + Cu; S6 with acute subapical tooth (Figs. 52b, c).

Description. Female: Length 15 mm; forewing length 12 mm. Inner orbits diverging above; shortest distance between eyes 0.91 frontal length of eye; head wider than long; clypeal protuberance in profile 0.63 eye width; mandible with subapical tooth; flagellomere 1 equal to combined length of next three flagellomeres and 0.88 as long as scape (excluding basal bulb); second flagellomere equal to 0.84 length of flagellomere 3; flagellomeres 4-9 about equal in length and each segment slightly longer than wide; last flagellomere equal to 0.72 length of flagellomere 1; distance between posterior ocelli 1.18 ocellocular distance; distance from median ocellus to posterior ocellus equal to 0.52 ocellocular distance. Marginal cell length equal to 0.85 distance from apex of cell to wingtip; cu-v of hind wing slightly longer than second abscissa of M + Cu; vein M 4.67 times as long as second abscissa of M + Cu; jugal lobe about half as long as vannal lobe. S6 with distinct acute, posteriorly projecting, subapical tooth (Figs. 52b, c). *Coloration.* Black except facial marks yellow (Fig. 52a); malar space, narrow apical margin of clypeus and median area of mandible reddish brown. *Pubescence.* Like *A. epaphrodita* except T1 with narrow apical band of appressed white hair; T2 with distinct apical white band about twice as wide as that of T1; T3 with distinct apical white band about twice as wide as that of T2; white, appressed, band of hair on T4 departing from margin medially. *Punctation.* Like *A. epaphrodita* but apicomedian margin of T4 impunctate and about twice as wide (0.39 mm).

Type material. Holotype female: Australia, Western Australia, top of Napier Range, Windjana Gorge, Kimberley Div., 10 April 1980, G. Anderson, D. Symor/on *Trichodesma* sp./WAM 87-1303/#350 *Amegilla (Amegilla?)* sp. det 1987, female, by T. F. Houston [Perth].

Comments. This species is most closely related and similar to *A. epaphrodita* from which it differs by the characters given in the *Diagnosis.*

Etymology. This species is dedicated to Terry F. Houston for his meticulously illustrated and fine work on Australian bees.

APPENDIX 2. LECTOTYPIC AND NEOTYPIC DESIGNATIONS

Each section (Lectotypes and Neotypes) of this Appendix is arranged alphabetically by author. Each type designation is arranged in the following sequence: original combination, type locality (TL), sex, label data (L) with each label separated by a slash, type depository in brackets according to the list given in Methods, and notes (if any). Each specimen bears a red lectotype or neotype label.

LECTOTYPES

Lectotypes are designated for various anthophorine and habropodine species when syntypic series exist without published designations of holotypes. Even authors who labelled a type, as distinguished from paratypes or cotypes, often failed to indicate which specimen was the type (= holotype) in their publications. Because of superficial similarity of species in different subgenera, type series are sometimes composite. Designation of lectotypes is the simplest way to clarify such problems. The genus and subgenus to which each name belongs can be determined through the index function of Appendix 3.

T. D. A. Cockerell

Podalirius cleomis (TL: New Mexico, Sante Fe Co., Santa Fe. Male. L: Ckll. 4452., Sta. Fe, NM., Veri Boyle/Co-Type No. 3404 U.S.N.M./ P. cleomis Ckll. COTYPE) [Washington, D.C.]. Cockerell's "cotypes" are normally paratypes, but no "type" (= holotype) can be found for this and the next species.

Podalirius vallorum (TL: New Mexico, Dona Ana Co., Las Cruces. Female. L: Ckll 4795, on *Ipomoea*/Las Cruces NM/P. vallorum COTYPE) [Washington, D.C.].

J. Dours

Anthophora badia (TL: México. Male. L: Mex 58/4 males, 2 females/Anthophora badia n. sp./ Museum Paris, Coll. O. Sichel 1867) [Paris]. 19 male paralectotypes all with the label "Museum Paris, Coll. O. Sichel 1867". In addition 1 had no other label, 2 with "Mex 58", 12 with "Oaxaca", 2 with "Oax. Salle" and 2 with "Orizaba 66" [15 Paris, 4 Lawrence].

Anthophora belieri (TL: Sicily. Female. L: Sicile/153) [Paris].

Anthophora laticincta (TL: France, Corsica. Female. L: Cors/Anthoph laticincta Sich n. s. 3 females/ = nigro-cincta Lp. v. female a Jurin ghli/ Drews, J.) [Paris].

H. Friese

Anthophora fulvitarsis murutica (TL: Afghanistan, Qandahār, Ma'rūt. Male. L: Caucasus, Murut)

[Berlin]. The rest of the type series, 3 males and 1 female, are *Anthophora fulvitarsis* Brullé and are not conspecific with the lectotype.

Anthophora villosula malaccensis (TL: Malaysia, Perak, Taiping Hills. Male. L: Malacca, Taip. Hills, Butt.-Reep, on *Ipomoea*) [Berlin]. The single female of the type series is *Amegilla urens* (Cockerell).

A. Lepeletier de S. F.

Anthophora albigena (TL: France, Lyon. Female. L: A. albigena female) [Paris].

Anthophora balneorum (TL: France, Pyrenees. Female. L: Balneorum female) [Paris].

Anthophora biciliata (TL: Algeria, Oran. Female. L: A. Biciliata female) [Paris].

Anthophora intermedia (TL: France, Paris. Female. L: A. intermedia, St. Farg.) [Paris].

Anthophora romandii (TL: Algeria, Oran. Male. L: Romandii male) [Paris].

F. Smith

Anthophora sicula (TL: Sicily. Female. L: A. sicula Smith/B. M. Type Hym. 17B595b) [London]. Smith's male of *A. sicula* was renamed as *A. pseudosicula* Hedicke, 1929.

Saropoda bombiformis (TL: Australia, New South Wales, Richmond River, 28°53'S, 153°35'E. Female. L: Australia, Richmond River/Smith Collection, Mrs. Farren White, collection no. 99-303) [London]. This is the same specimen that D. B. Baker designated as lectotype in manuscript in 1983.

NEOTYPES

In order to stabilize the following names and place them in subgeneric categories (see the above text) I have designated the following neotypes. Data are presented as for lectotypes.

A. Brullé

No type material of the following Brullé species has been found.

Anthophora affinis (TL: Algeria. Male. L: I. Pons, 13-5/Museum Paris, Coll. J. de Gaulle 1919/A. affinis) [Paris]. The male can be separated from other species by the absence of midtarsal and midbasitarsal brushes and the presence of a middistitarsal brush, as well as an apically emarginate S6. The topotypical neotype agrees with the original description.

Anthophora fulvitarsis (TL: Algeria. Female. L: A. fulvitarsis Brullé) [Paris]. The female has a yellow inverted T-shaped mark on the clypeus and the labrum is mostly yellow. The legs are mostly covered with orange hair; the thorax is ochraceous and the metasomal terga have sparse but distinct apical bands of ochraceous to white hair. The neotype is topotypical and agrees with the original description.

T. D. A. Cockerell

Podalirius cardui (TL: New Mexico, San Miguel Co., Las Vegas. Male. L: Las Vegas, N. M., July 11. (Ckll.)/at flrs. of *Cleome serrulata*/Anthophora cardui Ckll. male) [Washington, D.C.] *P. cardui* is a junior synonym of *Anthophora montana* Cresson. The distinguishing features are illustrated in Figs. 16a, b, d, f-k.

Podalirius lesquerellae (TL: New Mexico, Socorro Co., 12 mi E. (19.3 km) San Antonio (original type locality was Dona Ana Co., Mesilla). Male. L: New Mexico, Socorro Co., 12 mi. E. (19.3 km) San Antonio, IV-11-77, F. D. Parker) [Washington D.C.]. No cotypes of this species have been discovered although I have looked for them in almost every North American collection. The only species of New World *Anthophora (Pyganthophora)* that could be confused with *Anthophora lesquerellae* is *A. vannigera* Timberlake. *A. lesquerellae* male has a black apical rim on the labrum and the subapical tooth is on the apical fifth of the mandible. *A. vannigera* male has no black apical rim (it is all yellow) on the labrum and the subapical tooth is slightly distal to the midpoint of the mandible. *A. lesquerellae* has grey pubescence and is 12-15 mm long.

J. Dours

Almost all of Dours' type material (except for the lectotype material listed above) was destroyed by a bomb at Amiens, France in WW I. An exhaustive search at the Paris Museum, as well as at the museums at Lyon, Geneva, and Basel, failed to turn up any additional Dours' type material.

Anthophora albocaudata (TL: Gabon, N'kogo River, Ogodue, 0°27'N, 9°25'E (original type locality was Guinea). Female. L: Congo Franc., Ogodue N'kogo, J. Bouysson 1901/[Vachal's determination label] 1902, Anthophora albocaudata Dours) [Paris]. *A. albocaudata* can easily be recognized by its large size (about 19 mm), its yellowish-white integumental facial marks, upper half of thorax with orange pubescence, T1-T3 all black and T4 and T5 with mostly white hair. See *Amegilla paradoxa* and *A. nonconforma* for comparison. The neotype agrees with the original description and came from a locality as near to the type locality as I could find.

Anthophora godofredi (TL: Cape Verde Islands, São Nicolau (original type locality was São Vicente). Female. L: Is. Capo Verde, S. Nicolau, 0-600 m, XII-1898, L. Fea/P. Herbst Collection, Ex Reed) [San Francisco]. This species, easily recognized in the Cape Verde Islands, is almost all black but with a conspicuous apical band of white hair on T1 and all of the legs mostly covered with red hair. The neotype agrees with the original description.

Anthophora oxygona (TL: Spain, Sierra de Guadarrama. Male. L: 1149/v. oxygona Drs./Esp.) [Paris]. The name *A. oxygona* has been

applied to various species of *Anthophora*. I have even seen a determination label of *A. oxygona* on an undescribed species of *Pachymelus*. From material in the Paris Museum and studying the original description I am certain that *A. oxygona* is a junior synonym of *Anthophora robusta* (Klug), a well known Mediterranean species. It is easily recognized by its large size (17-20 mm), upper half of the thorax and T1 and T2 with fulvous hair and the middistitarsus without a lateral fringe of black hair. It can be confused with *Anthophora fuliginosa* Morawitz which has a well developed middistitarsal lateral fringe of black hair and is broadly black along all of the lateral margin of the clypeus (*oxygona* has only a small laterobasal spot on its clypeus and is all yellow below the anterior tentorial pit).

Anthophora rufolanata (TL: South Africa, Cape Province, Kaffraria. Male. L: Capland, Willowmore, Aug. 25, 1918, Dr. Brauns) [Pretoria]. This species, endemic to the Cape Province of South Africa, can be recognized and separated from its close relative, *Anthophora vestita* Smith, by the yellow to red hair (mixed with black) on the thoracic and metasomal dorsum and the lack of a middistitarsal lateral fringe of hair. I found 16 specimens at the British Museum (Natural History) determined by Cockerell as *Anthophora rufolanata*. His material agreed well with the original description and I have followed his interpretation of the species.

Anthophora tarsata (TL: México. Male. L: Mejico, Mus: Drews, Tarsata Sichel, 02: sr.) [Copenhagen]. *A. tarsata,* a junior synonym of *Anthophora californica* Cresson, is easily recognized in the western U. S. and the northern half of México by the white, apical, integumental bands on the metasomal terga and the red legs. The hind tibia of the male is greatly inflated with a large anterior tooth. The topotypical neotype agrees with the original description.

Anthophora zonata analis (TL: Equatorial Guinea, Rio Benito, 1°36'N, 9°37'E. Male. L: San Benito, Guiral 1885, 5335-85) [Paris]. This is a dark form of and conspecific with *Amegilla acraensis* (Fabricius). It is almost all black with scattered white hairs on the head, thoracic scutum and anterior half of the thorax, and T4 and T5 have predominately white hair. This topotypical specimen agrees with the original description.

W. Erichson & J. Klug

Megilla sesquicincta (TL: India, Pondicherry State, Karikal. Male. L: SOUTH INDIA, Pondicherry State, Karikal, April 1964 (P. S. Nathan)) [Lawrence]. The supposed type material of *M. sesquicincta* in Berlin, consisting of four specimens, is not from the type locality nor of the proper sex. There is no doubt of its identity from Erichson's description and from where it occurs in India. The head and thorax are almostly completely covered with white hair, T1 and T2 are all black, T3 and T4 have medially interrupted apical bands of white hair and T5 has white hair laterally. See *Comments* under *Dizonamegilla* for further discussion.

E. Germar

Megilla subterranea (TL: France. Male. L: II-23-1837) [Paris]. There is almost no recognizable remnant of Germar's material in the museums at Berlin, Hamburg, Eberswalde, Frankfurt or Munich. In Paris I found material which is topotypical, agrees well with the original description and may even be type material of Germar's. This large species is common in the Mediterranean region. The head has mostly long pale hair, scutum has long black hair, scutellum, metanotum, propodeal area and T1 with long white hair, T2 and T3 with mostly dark hair, and the rest of the terga has mostly white hair except for the median apical patch of dark hair on T5.

J. Giraud

Anthophora obesa (TL: Italy, Piemonte, Fenestrelle. Female. L: 34-72) [Genoa]. This specimen was collected on the 34th expedition on the 26-29 July, 1872 (according to the field notes in the Genoa Museum which were brought to my attention by R. Poggi). I could not find type or topotypical material of *Anthophora obesa* in the Paris Museum. Subsequent searching in other museums uncovered this specimen in Genoa. *A. obesa,* a junior synonym of *Anthophora balneorum* Lepeletier, is recognized by its almost all black head, pale to yellow thorax and almost all black metasoma dorsally, except T1 and T5 apicomedially have pale to yellow hair.

J. Klug

Megilla farinosa (TL: Egypt. Male. L: Aegypten, Schinker/Anthophora farinosa Klg. [Alfken's determination label]/Anthophora farinosa Klug [Lieftinck's determination label]) [Berlin]. The female that is labeled "1467/Type [orange label]/farinosa Klug* [yellow label]/tabsachlich nicht *farinosa* [Lieftinck's handwriting]/ This specimen is not the type, cf. with Priesner 1957, p. 91 [D. Baker's handwriting]" is not *M. farinosa*. From the Klug material in Berlin I have selected as neotype the above male which agrees with Priesner's (1957, see pp. 14, 19 and 90 for separation from other species and a description) interpretation of *Amegilla farinosa*.

A. Lepeletier de S. F.

Anthophora atrocincta (TL: Senegal. Male. L: Cap.) [Paris]. Although most of Lepeletier's species are represented in the Paris Museum collection, I was unable to find suitable material for lectotypic designation. *A. atrocincta* is one of the most distinctive African species. The upper half

of the head and thorax and T3-T5 are covered with thick yellow-orange hair. the lower half of the head and thorax are with thick white hair and T1 and T2 are all black except for a white band of apical hair on T2.

Anthophora nasuta (TL: Algeria, Laghouat (original type locality was Oran). Male. L: Laghouat, S. Algérie, III-IV-29, Dr. R. Meyer/Anthophora nasuta Lep./nasuta Lep. det. Dr. H. Priesner) [Ansfelden]. No type or topotypical material was found in the Paris Museum. The male of *A. nasuta,* a junior synonym of *Anthophora fulvitarsis* Brullé, has the apical margin of the labrum strongly reflexed outward, the midleg has a well developed midbasitarsal and middistitarsal lateral fringes of hair, T1 and T2 are covered with erect pale hair which is denser toward the apical margin, T3-T6 has distinct apical bands of pale hair. This large Mediterranean species is so distinctive that it should not be confused with any other species.

H. Saussure

Habropoda (Pachymelus) heydenii (TL: Madagascar, Diego Suarez. Male. L: Madagascar, Diego Suarez (Vachal Collection) 1911) [Paris]. The type is not in the Senckenberg Museum as indicated by Saussure (1890). There is no type material in Berlin, Paris, Geneva or Basel. The topotypical specimen agrees exactly with the original description and the species can be easily recognized by its essentially all black body with orange hair covering the head, propodeal area, legs, T1, T4 laterally, apical halves of T5-T7 and the sterna.

J. Vachal

Anthophora aerizusa (TL: Gabon, Ogooué (original type locality was Sierra Leone). Male. L: Ogooué/Congo) [Paris]. The locality Ogooué in Gabon can refer to any of the following Provinces: Moyen-Ogooué, Ogooué-Maritime, Ogooué-Ivindo, Ogooué-Lolo or Haut-Ogooué. After looking carefully through the Vachal and other bee collections in the Paris Museum I was unable to locate several Vachal types of anthophorine bees. However, the specimen listed above as neotype agrees with the description of *aerizusa. Amegilla aerizusa* is extremely similar to *A. caelestina* (Cockerell), both of which are bees with powder blue metallic hair on the metasomal terga without a predominance of black hair intermixed (as in *A. guinea* Strand). The only reliable way to separate them is from their differing genital capsules. *A. aerizusa,* from the dorsal aspect, has a definite angle on the lateral margin near the apex of the gonocoxite, the penis valve bridge is basally simple and very small (width of bridge equal to about half the width of the apex of a penis valve from dorsal view) and the gonostylus is short and barely exceeds a line drawn from the inner margin of the apex of the gonocoxite in dorsal aspect. *A. caelestina* from the dorsal aspect has no angle but is smoothly rounded on the lateral margin near the apex of the gonocoxite, the penis valve bridge is basally emarginate and broad (width of bridge equal to about width of the apex of a penis valve from dorsal view) and the gonostylus is long and greatly exceeds a line drawn from the dorsal aspect paralleling the inner margin of the apex of the gonocoxite.

APPENDIX 3. SPECIES OF ANTHOPHORINI AND HABROPODINI WORLDWIDE (INCLUDING INDEX).

The arrangement under each entry is as follows: specific or subspecific name, author, year, current generic status (symbols for names given below), original genus if different from current one in parentheses, zoogeographic region (symbols for regions given below), notes and synonymy or homonymy or new combination, and the page number(s) that refers to that name in the text. Symbols and their meanings for generic names are: Am, *Amegilla;* An, *Anthophora;* Ha, *Habropoda;* Po, *Podalirius;* Un, Unknown to me. Symbols and their meanings for zoogeographic regions are: A, Australian; E, Ethiopian; N, Nearctic; O, Oriental; P, Palearctic; T, Neotropical. If more than one zoogeographic region symbol is given, then the majority of the species' distribution is in the first region and to a lesser extent the species is distributed in the second or even to a lesser extent in the third region.

abessinicus (Friese), 1917 *Pachymelus* (An) **n. comb.**, E, n. name for *An. aethiopica* Friese, 1911, not Cameron, 1905

abdominalis Illiger, 1806 *(Megilla) nomen nudum* = *Ammobates rufiventris* Lepeletier, 1825, according to Gerstaecker, 1869

abjuncta Cockerell, 1922 An, O **(496)**

abramowi Fedtschenko, 1875 An, P **(474, 476)**

abroniae Timberlake, 1937 An, N **(494)**

abrupta Say, 1837 An, N (= *An. sponsa* Smith, 1854) **(448, 451-453, 476-479)**

abruptella Cockerell, see *centriformis* Cresson **(537, 540)**

acervorum Linnaeus, see *plumipes* (Pallas) **(439, 440, 448, 458, 460)**

acraensis (Fabricius), 1793 Am *(Apis),* E (= *An. bipartita* Smith, 1854 **n. syn.**; = *An. flavicollis* Gerstaecker, 1857 **n. syn.**; = *An. analis* Dours, 1869 [as *zonata* ssp.] **n. syn.**, dark form; = *An. hemithoracica* Sichel, *nomen nudum* in Dours, 1869; = *An. advena* Smith, 1879; = *Po. aethiopicus* Cameron, 1905 **n. syn.**; = *An. tellervo* Strand, 1911 **n. syn.**, dark form; = *An. ugandae* Meade-Waldo, 1914 [as *nubica* ssp.]

tecta Smith, see *dufourii* Lepeletier
tedshenensis Radoszkowsky, 1893 An, P (=*Po. tedthenensis,* [sic] Dalla Torre, 1896) **(476)**
tekkensis Gussakovsky, 1935 Un (An), P **(450)**
tellervo Strand, see *acraensis* (Fabricius) **(506)**
tenella (Klug), 1845 An *(Saropoda),* P **(492)**
teneriffensis Cockerell, see *quadrifasciata* (de Villers)
tenuiciliata Alfken, see *albosignata* Friese
terminalis Cresson, 1869 An, N (=*An. pernigra* Cresson, 1879 **n. syn.** [black form]; =*Ceratina bidentata* Provancher, 1882; =*An. nudata* Provancher, 1888; *An. subglobulosa* Provancher, 1888; =*Po. syringae* Cockerell, 1898 **n. syn.**; =*An. nubiterrae* Viereck, 1903; =*Clisodon neofurcata* Sladen, 1919 **n. syn.**; =*Po. sibiricus* Gussakovsky, 1932 **n. syn.**; =*Clisodon sperryi* Cockerell, 1937 [as *terminalis* ssp.] **n. syn.** [red form]) **(449, 486–489)**
terminata (Smith), 1879 Am (An), E (no. 5, not no. 4) **(506)**
terminata Smith, see *aurulentocaudata* (Dours)
ternatensis (Cockerell), 1910 [as *zonata* ssp.] Am (An), A **(511)**
tersa Erichson, see *altaica* Radoszkowsky
testaceipes Morawitz, 1888 An, P **(462)**
tetra Friese, see *armata* Friese
tetradonta Cockerell, 1933 An, E (=*An. livingstonei* Cockerell, 1938 **n. syn.**; =*An. aureohirta* Cockerell, 1946 **n. syn.**) **(491,492)**
tetrataeniata (Gribodo), 1894 Am (An), P **(505)**
texana Cresson, see *californica* Cresson
thalassiana Cockerell, see *porterae* Cockerell
thomsoni Saunders, 1882 An, P **(496)**
thorogoodi (Rayment), 1939 Am (An), A **(511)**
tibialis Morawitz, 1894 An, P **(492)**
tienmushanensis Wu, 1979 *Elaphropoda,* P
tinctula Cockerell, see *peritomae* Cockerell
tinsleyella Rayment, see *chlorocyanea* (Cockerell)
tomentosa Mocsáry, see *podagra* Lepeletier
tomentosa Friese, see *festivus* (Dours)
torensis (Priesner), 1957 Am (An), P **(515)**
torrida Smith, see *calens* (Lepeletier)
torridella Meade-Waldo, see *pygmaea* Meade-Waldo
townleyella Rayment, see *pulchra* (Smith)
triangulifera (Cockerell), 1933 Am (An), E (=*An. luluana* Cockerell, 1933 **n. syn.**) **(506)**
trichopus Hedicke, 1940 An, P **(496)**
trichroma Friese, see *dorsalis* Vachal
tricincta Friese, see *arequipensis* Brèthes
tricolor (Fabricius), 1775 An *(Andrena),* T (=*Megilla nigrita* Fabricius, 1804 **n. syn.** [dark form]; =*An. krugii* Cresson, 1878) **(466, 468, 535)**
tridentata (Friese), 1899 An (Po), EP **(492)**
tridentella Priesner, 1957 An, P **(492)**
trifasciata Radoszkowsky, 1886 An, P **(496)**
trilineata (Pérez), 1906 An (Saropoda), P **(492)**
tristissima (Cockerell), 1904 [as *infernalis* ssp.] Ha *(Emphoropsis)* **n. comb.,** dark form, N (=*Emphoropsis interspersa* Cockerell, 1905 **n. syn.**; =*Emphoropsis rugosissima* Cockerell, 1905 **n. syn.**) **(447)**
tristrigata Spinola, 1851 (An) =*Alloscirtetica* (Anthophoridae; Eucerini)
trochanterica Morawitz, 1888 An, P **(476)**
tschelcarica Ponomareva, see *retusa* (Linnaeus)
tsushimensis Cockerell, see *florea* (Smith)
tuberculilabris Dours, 1869 An,E **(492)**
tubifera (Cockerell), 1933 Am (An), E **(515)**
tumidifrons Lieftinck, 1974 Ha, O
tunicata Gistel, 1857 Un (An), P **(450)**
turanica Fedtschenko, see *plagiata* (Illiger)
turcomanica Morawitz, 1888 An, P **(464–466)**
turneri Cockerell, 1909 Ha, O
ugandae Meade-Waldo, see *acraensis* (Fabricius)
uljanini Fedtschenko, 1875 An, P **(460)**
uniciliata Sichel, 1860 Un (An), P **(450)**
unicincta Friese, see *somalica* (Magretti)
unicolor (Saussure), 1890 *Pachymelus* (Ha) **n. comb.,** E
unispina Wu, see *iole* Bingham
unistrigata Dours, 1869 Un (An), T **(450)**
urbana Cresson, 1878 An, N (=*Po. alamosanus* Cockerell, 1896; =*An. catalinae* Cockerell, 1899 **n. syn.** [red form]; =*An. nebracensis* Swenk, 1909 **n. syn.**; =*An. leucostomella* Cockerell, 1923 **n. syn.**; =*An. clementina* Cockerell, 1939 [as *catalinae* ssp.] **n. syn.** [red form]; =*An. nicolai* Cockerell, 1939 **n. syn.** [red-yellow form]) **(456, 466, 468, 469, 489)**
urens (Cockerell), 1911 Am (An), O **(513, 556)**
ursina Cresson, 1869 An, N (=*An. pyralitarsis* Dours, 1869; *An. simillima* Cresson, 1878 **n. syn.**; =*An. euops* Cockerell, 1903 **n. syn.**; =*An. californiensis* Michener, 1936 [as *simillima* ssp.] **n. syn.** [dark form]) **(465, 466)**
usbekistana Cockerell, 1930 An, P **(496)**
usticauda Cockerell, 1912 An, T (=*An. cinerior* Cockerell, 1949 [as *usticauda* ssp.] **n. syn.**) **(496)**
utahensis Michener, see *porterae* Cockerell
valga (Klug), 1845 An *(Megilla),* P **(473, 476)**
vallorum (Cockerell), 1896 An (Po), N **(454, 476, 478, 480, 481, 555)**
vanderysti (Cockerell), 1936 Am (An), E **(504)**
vannigera Timberlake, 1951 An, N **(460, 462, 556)**
vara Lepeletier, see *quadrimaculata* (Panzer)
varians Friese, see *plumipes* (Pallas)
varicolor Illiger, 1806 *(Megilla) nomen nudum*
variipes Morawitz, 1894 Un (An), P **(450)**
vedettus Nurse, see *atroalba* Lepeletier
vegeta (Bingham), 1896 Am (An),O **(511)**
velocissima (Fedtschenko), 1875 Am (An), OP **(510)**
velutina (Friese), 1909 Am (An), E **(510)**
venerabilis Cockerell, see *lanata* (Klug)
ventilabris Lepeletier, 1841 An, P (=*An. nigrocinctula* Dours, 1869 **n. syn.**) **(464)**
ventiscopula Wu, 1984 Ha, P
ventralis Michener, see *cressonii* (Dalla Torre)
vernalis Morawitz, 1878 An, P **(462)**
vernayi Cockerell, see *xanthostoma* Cockerell
versicolor Friese, 1925 An, T **(468)**
vestibula Cockerell, see *vestitula* (Cockerell)
vestita Morawitz, see *vestitella* Brooks **(474)**
vestita Smith, 1854 An, E (=*Podalarius* [sic] *pallidicinctus* Cameron, 1905 **n. syn.**; =*An. laticeps* Friese, 1911 **n. syn.**; =*An. griseovestita* Cockerell, 1914 **n. syn.**; =*An. ampliceps* Friese, 1915 [n. name for *An. laticeps* Friese, 1911, not Friese, 1905] **n. syn.**; =*An. sinuatitarsis* Friese, 1925 **n. syn.**; =*An. greyae* Cockerell, 1931 **n. syn.**) **(446, 492, 495, 543, 557)**